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AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

SARATOGA, N. Y., JUNE 24-26, 1903.

The convention was opened by the president, Mr. G. W. West, with the usual formalities, the attendance being unusually large. The presidential address began with a brief review of the extraordinary conditions of congestion on the railroads because of large volumes of business during the past year. This had brought new problems, which had been successfully solved. Tonnage rating was regarded as a most important element in train operation. By placing the rating of locomotives in the hands of one man, a gain of one train in five had been obtained with one class of locomotives. Tonnage rating, however, had been overdone. With the introduction of the wide firebox on locomotives had come a danger of a considerable loss through waste of fuel while standing still. The speaker believed that locomotive failures should come before the association in discussions. He had found that 20 per cent. of the failures represented 80 per cent. of the cost. High-speed tool steel was referred to as a great blessing in permitting the increase of capacity of old tools. This amounted to as much as 100 per cent. in some cases. During the past year 3,582 locomotives had been built in this country, which was equivalent to one every working hour during the year. Of these locomotives, 1,297 weighed 90 tons or over, and 742 were compounds. The speaker then supplemented the remarks of President Waitt last year on the opportunity presented the association in the matter of scientific research, which was greatly needed. He referred to the recent legacy of \$1,000 from Jerome Wheelock for this purpose, and urged the necessity for establishing representative membership in order to defray the expenses involved in systematic work of this kind. He also referred to THE AMERICAN ENGINEER Tests,

which received the endorsement of the association last year. He said:

"Attention was directed last year by President Waitt to the elaborate series of tests on locomotive draft appliances which are being conducted at Purdue University by Professor Goss for THE AMERICAN ENGINEER AND RAILROAD JOURNAL at its own expense. The association endorsed this commendable undertaking by authorizing the Executive Committee to assist in the work, which will be reported upon at this convention by a special committee. This research has already placed the study of stacks beside that of exhaust nozzles, which were investigated by the association in 1896. Much yet remains to be done in order to apply the best methods of design to large locomotives. The conclusions of Professor Goss with reference to stacks appear in the current number of THE AMERICAN ENGINEER, revealing valuable results already attained and indicating important lines for further investigation."

The address was a thoughtful and able review of the motive-power situation.

In the report of the secretary it was shown that the active membership was 699, associate 17, honorary 36, or a total of 752. The funds in the hands of the treasurer amounted to \$3,085.66, with no outstanding bills. This amount included a legacy of \$1,000 from Jerome Wheelock, which, it is understood, is to be used for research work by the association. The Executive Committee suggested the following changes in the constitution for the purpose of providing additional funds for this work:

Article 3, Section 1, an addition: "One representative member may be appointed by any railroad company to represent its interests in the association; such appointment shall be in writing, and shall emanate from the president, general manager or general superintendent. Such member shall have all the privileges of an active member, including one vote on all questions, and in addition thereto shall, on all measures pertaining to the determination of what tests shall be conducted by the association or the expenditure of money for conducting same, have one additional vote for each full 100 engines which are in actual operation or in process of purchase by the road or system which he represents. Such membership shall continue until notice is given the association of his withdrawal or the appointment of his successor."

Article 3, Section 3, an addition: "Representative members shall pay, in addition to their personal dues as above, an amount for each additional vote to which they may be entitled, as shall be determined each year by the Executive Committee, pro-rated upon the cost of conducting such tests as may be determined upon at each convention; provided, that no assessment shall exceed \$5 per vote per year."

Under the rules this must wait until next year for final action. There was no discussion.

A committee was appointed to take up with the Interstate Commerce Commission the question of applying hand-holds and grab-irons to locomotive tenders, which are required by the safety-appliance law.

An invitation was received from President Francis, of the St. Louis Exposition, to hold the next annual convention of the association at St. Louis in connection with the exposition.

TOPICAL DISCUSSIONS.

Long Locomotive Flues.—This subject was presented by Mr. H. F. Ball, who stated in general terms that long flues give no more trouble than short ones. Mr. Humphrey stated that he was not at all afraid of 20-ft. flues after his experience with them on the Chicago & Alton. Mr. Humphrey mentioned the matter of design of six-coupled locomotives with large drivers, which necessitated long tubes. In the recent Chicago & Alton 4—6—2 locomotives with 20-ft. tubes no trouble had been found. The additional heating surface incidentally obtained was somewhat beneficial. These engines had shown remarkable steaming qualities. Professor Goss said: "It goes without saying that if the length of the tube can be increased, there will be advantage in the performance of the boiler, provided the number is not reduced, so that as the subject appeals to me it is one of difficulties to be met with in increasing the

length of the tube. These difficulties, I fancy, are those of maintenance, keeping them tight, and perhaps the disadvantage of reduced draft. Now, if these disadvantages do not appear in the experience which has been with the long tube, it seems to me the argument is very strongly in favor of the more general use of longer tubes."

Methods of Setting Tubes.—Mr. Miller (P., C., C. & St. L.) believed it positively detrimental to use roller expanders which thinned the tubes. Roller expanders also distorted the holes in the flue sheets. Construction which would permit the tube sheets to yield as diaphragms was advocated and supported by a record of experience. Mr. Lawrence pointed to the fact that with increasing pressures flue practice had not advanced. Much of the present trouble was due to careless work at ash pits. Mr. Tonge had found it very beneficial to discard flue rollers. Cleaning flues and careful fitting to the sheets, the use of wide copper ferrules were all necessary. Mr. Humphrey believed the diaphragm construction to be the field for progress in overcoming flue troubles, which he characterized as serious and due to local conditions and a large number of causes. Mr. Bartlett reported favorable experience with spirally corrugated tubes on the Boston & Maine. The spiral corrugations apparently provided for expansion. Flue and other boiler troubles are evidently considered as the most important locomotive problems before motive power men to-day.

Grinding as a Method of Finishing Piston Rods and Valve Stems.—Mr. Vaughan introduced this subject by stating that his subject referred to grinding by the use of high pressures and the employment of stops. A very rigid machine was absolutely necessary. The work was done to save lathe cuts and secure accurate finish as compared with filing. As a result a piston rod could be centered and rough turned in about 1½ hours and could be completely finished by grinding in from 16 to 18 minutes. Valve stems requiring 45 minutes for lathe and file finishing could be ground in 10 to 12 minutes. Crank pins required 1 hour 45 minutes for centering, roughing, threading and finishing in the lathe, as compared with 20 to 22 minutes for grinding. Old rods with pistons on were ground just as they came from the engines in 30 to 35 minutes, whereas lathe work required 1 to 1½ hours. Old valve stems were ground in 25 to 30 minutes. The speaker placed great emphasis on the necessity for rigid grinding machinery, and was strongly in favor of grinding as a process in locomotive work.

Mr. Norton, of the Norton Emery Wheel Company, was given the privilege of the floor and spoke of the development of the manufacture of grinding wheels, which had exerted a vital influence on the possibilities of grinding. To-day soft steel is removed by wheels at a rate of a cubic inch of metal per minute. Machine tool features, rather than refinements for grinding, were now applied in grinding machinery. Pressures up to 6,000 lbs. were used in grinding large pieces, such as shafts. The utmost rigidity was necessary in the machines.

New Tool Steels.—This subject was presented by Mr. S. K. Dickerson (Lake Shore & Michigan Southern), who related experience at the Collinwood shops. As an instance of what could be done, he stated that fourteen tires had been bored with one tool for roughing out. It had been found that it often required more time to put work into readiness than was required for the cutting, which made it desirable to provide improved facilities for setting work. In many cases machines had failed to hold up the cut which the steel would carry. In boring tires speeds of 36 to 40 ft. per minute were used, and in turning tires, outside, speeds of 18 to 20 ft. The discussion showed the great importance of the new high-speed steels in all materials except cast iron, or on work which is light. Mr. Vaughan believed that the introduction of these steels constituted the greatest improvement in machine work in recent times. There had been a general waking up to a study of speeds and feeds and methods of putting work into machines which was not the least important effect of the steels. It would pay to spend more money on jigs and methods of reducing the labor charge and the cost of manipulating the tool. The new steels had done a service in drawing

attention to this fact. It would not do to stop with the steel itself. It requires perhaps twelve minutes to make a cut and an hour to set the work. The discussion was lively and interesting, reflecting the fact that tool steels are revolutionizing shop practice.

Range of Weights of Principal Parts of Locomotives.—Mr. R. H. Soule placed on record the weights of a number of heavy parts of locomotives which he had secured in connection with the determination of the capacities of traveling cranes for shops. A large amount of this information will be presented in the proceedings. In his remarks he gave a few very interesting figures, as follows:

"The heaviest weight of the complete boiler that is recorded is the Santa Fe tandem compound decapod by the American Locomotive Company, which weighs 66,313 lbs. That indicates, at once, in order to be safe and leave some little margin, that a general boiler shop crane which is going to handle all kinds of boilers should not be of less than 35 tons' capacity. The next item worthy of note is that of cabs; the heaviest wooden cab reported weighs 1,520 lbs., and the heaviest steel cabs will weigh over 1,000 lbs. more than wooden cabs. A full set of frames on the engine referred to weighs 21,200 lbs., which indicates that a 10-ton crane is not sufficient to handle them, and will probably require a 15-ton crane. A pair of cylinders bolted together complete in the case of the same heavy Santa Fe tandem compound decapod engine will weigh 27,420 lbs., showing at once nothing less than a 15-ton crane would be safe to provide for handling that class of work. The heaviest driving axle reported, referring to the same engine, weighs 1,875 lbs.; a pair of driving wheels on axles the same engine, being the main wheel with eccentric and straps on, weighs 9,855 lbs. Engine truck complete, Atlantic type, New York Central engine, weighs 10,250 lbs., something over 5 tons. The tender tank reported by the Baldwin Company weighs 13,680 lbs., showing at once that a 7½-ton crane is necessary; the tender truck complete, 9,060 lbs.; the tender complete, without coal or water, 48,900 lbs."

INDIVIDUAL PAPERS.

Draw Bars Between Locomotives and Tenders.—This paper, by Mr. Henry Bartlett (Boston & Maine), is presented in abstract. Mr. Wm. Forsyth differed with the author with reference to the use of springs and believed that the employment of friction draft gear on the rear ends of tenders would reduce the duty of the engine draft gear. Mr. Bartlett stated his opinion that there should be a positive tie, with no lost motion between engines and tenders. This was the more necessary with large locomotives. Mr. Vaughan believed a spring connection desirable, because it made it possible to utilize a portion of the weight of the tender to assist in steadying the engine. A flat buffer was preferred to a rounded form, because of providing wearing area and preventing cutting on curves. Mr. Van Alstyne favored spring connections, and argued in favor of greater capacity of the springs. He also believed wide, flat wearing plates desirable. The discussion was decidedly favorable to spring connections.

At this point a letter from Mr. F. D. Casanave, of the Pennsylvania Railroad, was read, stating that that road would install a locomotive testing plant as a part of their exhibit at the St. Louis Exposition, requesting the association to appoint a committee of four to represent the association in connection with tests of locomotives on the plant. Mr. F. H. Clark (C., B. & Q.) presented resolutions authorizing the president to appoint this committee. This important project evidently impressed the members. The resolutions were adopted.

Internal Combustion Engines.—This paper will appear in abstract. Mr. Soule did not think that the author had given fair consideration to the steam engine. He showed from the published accounts of the Collinwood shops that a horse power could be delivered at the motors on a consumption of 3 lbs. of coal and did not consider the gas engine as a strong competitor of steam.

The Metric System.—Mr. Angus Sinclair presented an individual paper urging the association to take official action condemning all legislation intended to promote the adoption of

the metric system in this country, and including resolutions which the author suggested in this connection. The paper was directed against the bill which will be again brought before Congress with the object of compelling the use of the metric system in government work, and cited as an objection the fact that nothing but confusion would result. Experience in so-called metric countries abroad had proven that the old units remained in use, and it was believed to be not only impossible to generally introduce the metric system in this country, but it was entirely unnecessary to attempt to do so in order to maintain trade with metric countries. The paper presented the case ably and concisely. After a very short discussion the resolutions were adopted, committing the association to a policy adverse to the metric system.

Light for Locomotive Headlights.—Mr. Wm. McIntosh read a brief statement concerning various methods of lighting locomotive headlights which will be referred to more fully in a future issue.

Effect of Tonnage Rating Upon the Cost of Conducting Transportation.—This paper will appear in abstract. Opinions expressed in the discussion were generally favorable to the views of the author as to the desirability of reducing maximum tonnage ratings to a basis which would permit of economical operation.

DISCUSSION OF COMMITTEE REPORTS.

Revision of Standards.—The adoption of M. C. B. standards for bolt heads and nuts was recommended; also that the distance between the backs of flanges of driving wheels be not less than 4 ft. 5½ ins. It was suggested that a committee be appointed to revise the shrinkage allowance for driving-wheel tires to provide for cast-steel wheel centers. The standard tire section was found to contain an error, and should be made to conform to that of the M. C. B. Association. At present steel tubes are not provided for in the standard tube specifications. It was recommended that these be included, that the M. C. B. standard axles and journal boxes be adopted by this association and that committees be appointed to revise the specifications of cast-iron wheels for tenders, and to revise the air brake and signal instructions. The recommendations were approved.

Piston Valves.—Mr. F. H. Clark presented the subject, calling attention to the apparent preference for the hollow piston valve because of its superior balancing features. Relief valves were believed to be somewhat deficient in meeting the expectations. Considerable difficulty had been experienced in the use of L-shaped rings. The shape of the section was important, and a short lip of the L seemed to be satisfactory. Good results had been secured from the new balanced slide valve (the American). A flexible connection in the valve stem was recommended in order to reduce the wear of valves. Straight bridges were believed to be more satisfactory than those cut diagonally.

Mr. Van Alstyne reported a difference of 6 to 1 in favor of piston valves in the matter of valve failures and 7 to 1 in Baldwin and cross compounds, running in the same service. A speaker gave, from the standpoint of traveling engineers, a very favorable opinion of piston valves. He referred to the weight of large valves as an important matter requiring attention. Mr. John Player presented interesting comments on piston valve practice, which will be referred to in another issue. It seemed to be the general opinion that while piston valves were not perfect, they constituted an improvement over the old form of slide valves. Mr. David Brown compared the piston valve to "a new baby in the family which needed looking after." The recommendations of the committee were referred to the executive committee.

Recent Improvements in Boiler Design.—This report will appear in abstract. Mr. Van Alstyne indicated the great importance of wider water spaces, not only at the mud rings, but also at the crown sheets. Flue troubles were not taken care of completely by anybody, and by most people not at all. They constituted a very serious problem. Mr. Player made an admirable argument for better circulation of water in boilers. This report led to a rather lengthy discussion of the details

of boiler construction. Mr. O. H. Reynolds directed attention to D. K. Clark's recommendations for tube spacing, which if carried out to-day would lead to much larger spacing. He wished to have tests made to demonstrate the facts with respect to tube spacing. Mr. Humphrey made a strong plea for further investigation of boiler troubles with a view of ascertaining how to construct boilers to overcome present troubles. He believed that if the association considered this subject only, next year, the time would be well spent, so important was it. The committee was continued, with instructions to carry on investigations at the expense of the association.

Electrically Driven Shops.—Mr. C. A. Seley, chairman of the committee, presented this admirable report, which is printed nearly in full in this issue. The speaker favored a three-wire system for general shop requirements. For lamp circuits 110 volts offered decided advantages. He was satisfied to accept 100 per cent. field control and 4 to 1 speed variation with a three-wire system for new shops now under construction under his direction. It was a simple system, and simplicity in electrical matters was very desirable. Mr. R. H. Soule considered condensing apparatus for power plants undesirable. He also mentioned crane service as one absolute necessity in modern shops. Mr. Soule referred to the absence of large cranes in the new shops of the Great Northern at St. Paul as an interesting development. Mr. Pomeroy spoke in favor of field control of various speed motors, it being commercially and electrically desirable. The maintenance of the horse power through the range of speeds was necessary. Such motors were fully developed and were considered standard commercially. Such motors would stand much higher overload at the low than at high speeds. Variable speeds without loss of efficiency were important. Variations of three to one on two wires had been successfully used at the works of Messrs. Vickers & Maxim in England.

Mr. Vaughan discussed the report from the standpoint of the four-wire, multiple voltage system of the Crocker-Wheeler Co., at the Collinwood shops. He emphasized the fact that the additional shop output necessary to obtain the returns from a variable speed system was only a little over 2½ per cent.; if that amount of increased output was obtained with a system of speed control, the additional cost was fully justified. He was positive that far more than 2½ per cent. was obtained because of the convenience of speed changing on the machines. The machine attendants acquired the habit of *changing speeds to suit the work*, and thus secure the maximum output of machines. He considered speed control one of the most valuable factors obtainable in a shop. He also put the question of individual driving squarely "up to the machine tool builders." If machines were built for the direct application of motors at the same price as for belt connection, it cost no more for motors than for belts, shafting and accessories. Tools for variable speed motors (not for expensive gear changes) should be no more expensive than belts and accessories. Tools which would cost \$250 or more should be so constructed. [This is a new view of individual driving which is as important as it is radical.—EDITOR.] The speaker was strongly in favor of the four-wire system. Four wires cost little more than three after the conduits were in. Lighting by two 120 volt arc lamps in series was entirely satisfactory at Collinwood. He did not believe that commutation would be satisfactory in large ranges of speeds with field control on what he called the standard motor. The three-wire system did give a constant horse power over the entire range. This had been considered necessary, but the speaker was not sure that it was. For example, it required nearly three times as much power to double the speed of a planer, and further information was necessary. For a load factor, he had found 30 per cent. sufficient to cover actual practice.

Locomotive Front Ends.—Mr. Vaughan spoke of the AMERICAN ENGINEER tests as establishing the conditions of the "front end" of a locomotive of the size of that at Purdue University as thoroughly as they ever would be. This was a good basis for further work, applying the results already obtained to larger engines. This would not be as difficult or

elaborate as the earlier work, and the committee wished to be continued to conduct laboratory tests on a larger engine. Mr. F. H. Clark (C., B. & Q.) reported in general terms the results of a road trial of the formula given in the conclusion of the report. This work showed that the engine steamed rather more freely with the larger stacks. Mr. Vaughan also reported on road tests on locomotives with 54 and 74 in. front ends, in which it was found that the formulae seem to apply to larger engines. The road tests were not yet completed, and the report next year will probably be of far greater value than any which can be given now. Mr. Quereau believed that laboratory tests only could give conclusive results. He believed the work to be in good hands with promise of good results. The committee was continued. Before the vote was taken a graceful tribute was paid the AMERICAN ENGINEER by Professor Goss for its service in connection with the conduct of these tests.

Standard Pipe Unions.—This committee recommended that the association should appoint a delegate to attend the convention of the National Association of Stationary Engineers, to co-operate with that organization with reference to this subject. Instead of doing this, the association at once adopted the standard which was presented last year, thus settling the question at once as far as this association is concerned.

Ton-Mile Statistics.—This brief report will be presented in

abstract. It showed that the usual mileage allowance for switch engines was about twice too high. Mr. Fowler went into the history of this subject, showing that the present unit was the result of averaging a number of guesses. He desired to have the work of the committee continued to include tests, by a convenient recording dynamometer, to secure data as to the actual work done by switch engines. Mr. Quereau spoke strongly in favor of ascertaining facts as to the cost of operating this equipment and thought it wrong to perpetuate the practice of guessing the mileage. He would like to use a ton mile basis in order to show what switch engines cost in terms of work done, but did not know how to do this. If this equipment costs 30 cents per mile it was well to know it. The result of a long discussion was a vote to continue the committee for positive recommendation next year after conference with the American Railway Association.

Mr. L. R. Pomeroy presented an interesting discussion with reference to the state of the art in the subject of steam turbines and their advantages over reciprocating engines.

The following officers were elected: President, W. H. Lewis; first vice-president, P. H. Peck; second vice-president, H. F. Ball; third vice-president, J. F. Deems; treasurer, Angus Sinclair.

After this action this very successful convention adjourned.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION, SARATOGA, JUNE 29 TO JULY 1.

The convention was opened by the president, Mr. J. W. Marden, with what appeared to be the largest attendance in the history of the association and larger than that of the Master Mechanics' Association. The convention was addressed by Mr. George H. Daniels, of the New York Central. Mr. Marden's presidential address began with a review of the unprecedented commercial condition of the country. Referring to the accomplishment of freight-car interchange, the speaker said, "Progress should be our watchword." The most important work at hand was the adoption of the standard car. A high tribute was paid to the association in its administration of car interchange by a statement of the fact that but sixteen cases had been submitted to the Arbitration Committee during the year. The speaker also reviewed the papers and reports individually.

The report of the secretary showed a total membership of 534, and an increase of 119,923 cars in the equipment represented. The funds on hand amounted to \$6,883.29, with no unpaid bills.

Mr. E. A. Moseley, of the Interstate Commerce Commission, in an address presented an argument for interchangeability in couplers, basing it upon a legal case involving a Miller and M. C. B. coupler between a locomotive tender and a dining car. The new law would cover such cases, and the safety-appliance law would soon cover all cars. He quoted figures to show the effect of the safety-appliance law in decreasing the injuries and fatalities in railroad service. A more rigid compliance with the law was being demanded by organizations of employees, and the speaker desired to direct the attention of the association to this fact and to the necessity for keeping equipment up to the highest standard as to safety appliances. September 1 would see a radical change in the law which will compel proper maintenance in this respect. Incidentally, Mr. Moseley gave deserved credit to Mr. M. N. Forney for a large part in the development of construction and methods to reduce the dangers to which trainmen are exposed. Mr. Moseley wished to include in the safety-appliance law the standard and recommended practices of the association, and hoped this might be accomplished. It was ordered that a committee be appointed to confer with the Interstate Commerce Commission upon safety appliances, and that this committee be continued from year to year.

TOPICAL DISCUSSIONS.

Four-wheel vs. Six-wheel Trucks for Passenger Cars.—Mr. W. P. Appleyard stated that the New York, New Haven & Hartford was running 60-ft. passenger cars on four-wheel trucks with satisfactory results, the cars weighing from 70,000 to 80,000 lbs., and had 4¼ by 8-in. journals. Satisfactory experience with four-wheel trucks was reported from the Santa Fé and the Jersey Central. They seemed to be satisfactory where used.

Ideal Arrangement for Repair Shops of Small Capacity.—Mr. G. N. Dow described the repair-shop facilities on the Lake Shore at Ashtabula, Ohio, where 2,500 cars are handled per day. This plant will be referred to again.

Modification in Height of Drop for Testing Axles.—Mr. E. D. Nelson showed that the M. C. B. drop tests are too severe for iron axles, which had led to complaints from manufacturers. He had found by investigation that comparatively few iron axles were made outside of railroad shops, and did not recommend a change. He thought it advisable to secure uniformity in axles of iron and steel. The discussion showed that it was becoming difficult to obtain scrap axles; that while they would not stand tests as well as steel, they seldom failed in service. This discussion may perhaps be considered as the "last will" of scrap-iron axles as far as discussions before this association are concerned.

Steel Cars.—Mr. A. L. Humphrey opened the discussion by predicting that in a few years no cars other than steel will be built. He had found composite cars of steel and wood as satisfactory as all steel cars as to repairs. The all steel car was better able to withstand wrecks. He had found more corrosion in the case of composite cars. A steel frame box car was considered a possibility. The speaker believed that the time of the steel car had arrived. Attention was needed to provide adequate draft gear and prevent corrosion. Steel cars were here to stay, and corrosion must be provided for. The speaker considered corrosion as vitally important. Mr. Sanderson made a point of the fact that composite cars need not weigh more than all steel cars.

Mr. Seley spoke favorably of composite construction. He thought it proper to lay aside the theory that the underframe should carry all the load. He believed it desirable to utilize the side framing as trusses to aid in carrying the load. He cited the weights and experience on the Norfolk & Western with composite construction. (This series of cars has been illustrated in this journal.—EDITOR.) The weights and performance were satisfactory. The trussed steel side frame

box cars on that road had not been at the shop for repairs. Steel frames for box cars were also considered necessary in order to provide proper strength for the end construction. The only steel underframe car the speaker would build would be a flat car. His preference was distinctly for composite construction. The cost, the proportion of revenue load, the labor required for repairs were all favorable to that construction. The speaker referred to the report of cost of repairs of composite cars on the Norfolk & Western as stated by Mr. W. H. Lewis in our June issue. Mr. Seley had found no serious corrosion in the framing of Norfolk & Western cars after two years' service. Painting was important. He presented the claims of the composite car from the standpoint of successful and entirely satisfactory practice and based his opinion upon experience with a series of designs of his own. These facts were not as plainly stated as this, but the opinions are well founded and well and definitely supported by experience.

Mr. Ball wished to see the association go on record in favor of steel members in underframes to take care of buffing and pulling stresses. Mr. Bentley did not believe corrosion a serious matter. His experience covered 16,000 steel cars. Mr. McIntosh said that the exterior surface of cars could be protected from corrosion by painting, and the inside would take care of itself. He considered this question a "bugbear." Mr. Mendenhall said that it would pay to build steel cars if they were to be thrown away after five years, because of the additional carrying capacity.

INDIVIDUAL PAPERS.

A Review of Decisions of the Arbitration Committee, an independent paper by G. L. Fowler.—The record of the work of this committee for twenty-four years is characterized as "an unbroken record of consistency, equity and justice." The author of the paper pays high tribute to the committee, to its members and to the association for the high-minded administration of the difficult work of arbitration, which had rendered possible the present interchange methods. The paper analyzes the decisions of the more than 600 cases ruled upon and discusses the underlying principles involved. These center about the defect card as an authorization for making repairs, the principle of inspection for safety, the responsibility of owners, the basis of repairs as a courtesy and not a money-making possibility, the use of wrong material and other well-known tenets of the rules. One effect of the paper will be an awakening of appreciation of the admirable work of the arbitration committee, another will be a better understanding of some of the principles mentioned.

The Metric System.—Mr. Sinclair read the same paper before both associations. This has already been mentioned in the report of the discussions at the Master Mechanics' Convention. The resolutions offered in the paper were adopted after a very brief discussion, and the subject disposed of. The metric system was emphatically "turned down" by both associations.

DISCUSSIONS OF COMMITTEE REPORTS.

Tests of M. C. B. Couplers.—This report described the new coupler drop testing machine. A separate knuckle test was recommended, and a revision of the coupler specifications proposed. In order to increase the strength of coupler changes in the contour seemed to be necessary, and it was recommended that this be done by progressive changes. The committee favored the "improved lines" of the Buckeye Malleable Iron & Coupler Company.—This discussion, and in fact, the report itself, was chiefly concerned with the construction of couplers and attachments for pulling cars out of sharp curves when the knuckle slots and pin-holes are abandoned. Several speakers argued for a more perfect fit between knuckles and couplers. A machine job instead of rough fitting was desired. The holes should be drilled and the pins turned. The committee recommended an increase in deflection in the guard arm test. The minimum weight specified in previous specifications was omitted. A new jerk test was suggested, which would permit of submitting the test to one instead of two couplers at a time. The committee wished to secure a satisfactory unlocking device with a rod to be operated from

both ends of the end sills and wished to continue efforts in this direction. The solid knuckle problem was believed to be solved by the device suggested by the committee and the immediate abolition of the knuckle slot and pin-hole was urged. The recommendations of the committee were ordered submitted to letter ballot.

Outside Dimensions of Box Cars.—This committee submitted drawings of proposed construction of a standard car (above the floor framing) asking for criticisms. The design was made to correspond with the inside limits of the American Railway Association and the outside dimensions recommended last year. In the discussion several members expressed the opinion that end construction of cars were almost always too weak. Very heavy construction should extend up at least 2 feet above the floor. The committee explained that the drawings were submitted merely to secure discussion. A discussion of details of construction of a standard car has actually begun. On this fact the association is heartily congratulated. The committee was continued for further report next year upon the design of car framing above the floor.

Standard Pipe Unions.—This report is the same as that presented to the Master Mechanics' Association, being a joint paper submitted to both associations. Mr. Quereau was the chairman of both committees. The recommended standard was ordered submitted to letter ballot.

Steam and Air Line Connections.—Mr. Bell explained the reason for recommending 2-in. steam lines. At times from 15 to 20 minutes is required to get steam through long trains at terminals where engines are changed, and this would be reduced by the use of the larger pipe. A hose larger than 1½ in. inside diameter was not considered desirable. An opening of 1½ in. through the gaskets of couplings was recommended. Mr. Seley characterized the report as marking a radical reconstruction of practice in car heating by steam. He pointed out the fact that construction difficulties must be met. The recommendations of the committee were approved and the questions of location of connections and size of couplers were submitted to letter ballot as a recommended practice.

Pedestal and Journal Box for 5 by 9 in. Journals.—The report was at once referred to letter ballot as recommended practice.

Standard High Speed Foundation Brake Gear.—This report will appear in abstract. Mr. E. M. Herr paid the committee a compliment upon the report. Mr. Seley thought it entirely feasible to make some of the parts of malleable iron without increasing weight. The recommendations were submitted to letter ballot as recommended practice.

Proper Design and Construction of Tank Car Equipment.—This report was not printed in advance. It contained a statement of the elements of safe construction, covering the construction and fastenings of tanks and frames and the provision of safety valves. It showed tank car practice to be in a very unsatisfactory condition and offered recommendations and plans for construction. This was an admirable report and very interesting. It included tests on safety valves to provide relief from dangerous pressure. The report was endorsed and ordered submitted to the American Railway Association. It will undoubtedly result in putting tank car practice in good shape. It was stated that the Union Tank Line would go into the improvement of its equipment in accordance with the recommendations of this extremely able report.

Supervision of Standards and Recommended Practice.—This report presented a few changes of minor importance. It suggested a change to make Sheet 19 consistent with the corresponding text, and a change of reference figures on the air-brake defect and to letters. The committee entered a protest against unnecessary changes. The recommendations of the committee were ordered submitted to letter ballot.

Side Bearings and Center Plates.—The conclusions of this report will be presented next month. Upon a motion, the center plate proposed by the committee was referred to the committee for complete data as to contour.

Draft Gear.—This committee presented a voluminous report of tests last year, and was instructed to report upon the service of draft gear this year. A record of service has been inaugurated, but it was thought necessary to wait for at least two years before attempting to compare information with reference to cost of maintenance. Therefore, no attempt was made to submit suggestions to be adopted as recommended practice. The committee was continued for report next year.

Cast Iron Wheels.—Mr. Waitt considered it very important to secure a conference between the committee and the manufacturers of wheels. Mr. Linstrom criticised the designs of the wheels. The committee was continued to confer again with the manufacturers for further report next year.

INTERCHANGE RULES.

The leading question involved the following suggestion from the Western Railway Club with reference to Rule 2 of the Interchange Rules:

"Empty cars offered in interchange must be accepted if in safe and serviceable condition, the receiving road to be the judge in cases not provided for in Rules 3 to 54, inclusive. Loaded cars offered in interchange must be accepted. If not in safe and serviceable condition, the receiving road to transfer the load at its expense."

The question was generally considered as being beyond the jurisdiction of the association. A roll call vote on submitting the question of letter ballot was decided adversely. The decisions, throughout, were in accordance with the recommendations of the arbitration committee. The entire discussion occupied exactly two hours, and no radical or very important changes were made.

ELECTION OF OFFICERS.

President, F. W. Brazler; first vice-president, W. P. Appleyard; second vice-president, Joseph Buker; third vice-president, W. E. Fowler; treasurer, John Kirby.

The convention adjourned.

PERSONALS.

Mr. Arthur H. Fetters has been appointed assistant mechanical engineer of the Union Pacific Railroad, with headquarters at Omaha. He has held the position of chief draughtsman for several years.

Mr. J. A. Doarnberger has been elected president of the International Railway Master Boiler Makers' Association. He is master boiler maker of the Norfolk & Western Railway at Roanoke, Va.

Mr. E. B. Thompson has been appointed master mechanic of the Minnesota and Dakota division of the Chicago & Northwestern, with headquarters at Winona, Minn., having been transferred from the Iowa and Minnesota division at Mason City, Iowa. He is succeeded at Mason City by Mr. William Hutchinson, transferred from Winona.

Mr. J. E. Muhlfeld, recently appointed general superintendent of motive power of the Baltimore & Ohio, has had a remarkable record of promotion. He was born in 1872, and was educated at Purdue University, where he was graduated in mechanical engineering in 1892. His first railroad service was in the shops of the Wabash Railroad at Fort Wayne. After serving as machinist apprentice, locomotive fireman, round-house foreman and general foreman on that road, he went to the Grand Trunk in 1899 as master mechanic at Port Huron, and was afterward master mechanic at Montreal. In 1901 he resigned to become superintendent of motive power of the Intercolonial of Canada. In October, 1902, he went to the Baltimore & Ohio as assistant to the general superintendent of motive power, and last February was appointed superintendent of motive power at Newark, Ohio. He was promoted to his present position June 1. He is undoubtedly the youngest official ever appointed to a position of such responsibility.

Mr. W. H. Marshall has been appointed general manager of the Lake Shore & Michigan Southern Railway and the subsidiary lines. Since the death of Mr. P. S. Blodgett last October Mr. Marshall has been carrying the responsibilities of management as general superintendent. Mr. Marshall has had a very unusual career. He began as machinist apprentice in the Rhode Island Locomotive Works and without the advantages of a technical school training became mechanical engineer of the works. After spending about eight years in newspaper and consulting engineering work, he entered railroad service May 1, 1897, as assistant superintendent of motive power of the Chicago & Northwestern. This was six years ago. Since that time he has been superintendent of motive power and general superintendent of the Lake Shore. His success is due to ability, good judgment and strong personal traits which enable him to surround himself with efficient and loyal subordinates. This journal announces his appointment with pride because of his former connection with it. People like to see such men achieve the highest success, because they deserve it.

EDWARD GRAFSTROM.

Those who knew him will not be surprised to know that in the emergency occasioned by the recent floods in Topeka, Mr. Grafstrom took an active part in efforts to rescue those whose lives were endangered, but it was a shock to all his friends to know that after saving 77 people in a small launch he was lost in the river. Mr. Grafstrom was in charge of a boat built in the railroad shops at Topeka for rescue work, and in returning for the last time on June 2 across the river, the boat was caught in the rapid water and capsized. All were saved except Mr. Grafstrom. He was an accomplished mechanical engineer and from natural ability, training and experience was an officer whose loss will be felt when such men are so greatly needed on our railroads. Readers will miss his contributions to this journal. He was a man of wide acquaintance and attractive personality, uniformly courteous and of distinguished appearance. He was a native of Sweden, and though a resident of this country for twenty years, remained a subject of King Oscar, to whom he owed his education. His first position in this country was in the shops of the Pennsylvania at Altoona. In 1886 he went to Columbus, and in 1892 became mechanical engineer under Mr. S. P. Bush, then superintendent of motive power. In 1899 he went to the Illinois Central as mechanical engineer and soon afterward entered the service of the Santa Fe in the same capacity. He held this position at the time of the accident in which he sacrificed himself in an effort to save others.

The nobility of his act and his response to the appeals of those who were in the greatest danger for days are impressive and altogether fine. He was lost in the culmination of his character.

His friends have inaugurated a memorial fund to which the members of the Master Mechanics' and Master Car Builders' Associations and others will have an opportunity to contribute. Mr. S. P. Bush of the Buckeye Malleable Iron & Coupler Company, Columbus, Ohio, is treasurer. He was associated with Mr. Grafstrom for many years and that the fund may be a large one is the hope of all of Mr. Grafstrom's friends and associates.

Contributions may be sent to this journal for transmission to Mr. Bush.

An efficiency of 1.6 per cent. in a mechanical and chemical process is very low and it at once suggests a great opportunity for improvement. This is the figure given in the paper by Mr. R. P. Bolton, before the American Society of Mechanical Engineers, as the efficiency of the combined system of apparatus from furnace to load in operating the passenger elevator system at Macy's department store in New York City. This 1.6 per cent. is the proportion of heat in the fuel represented by the live load traveled. The elevator system is hydraulic.

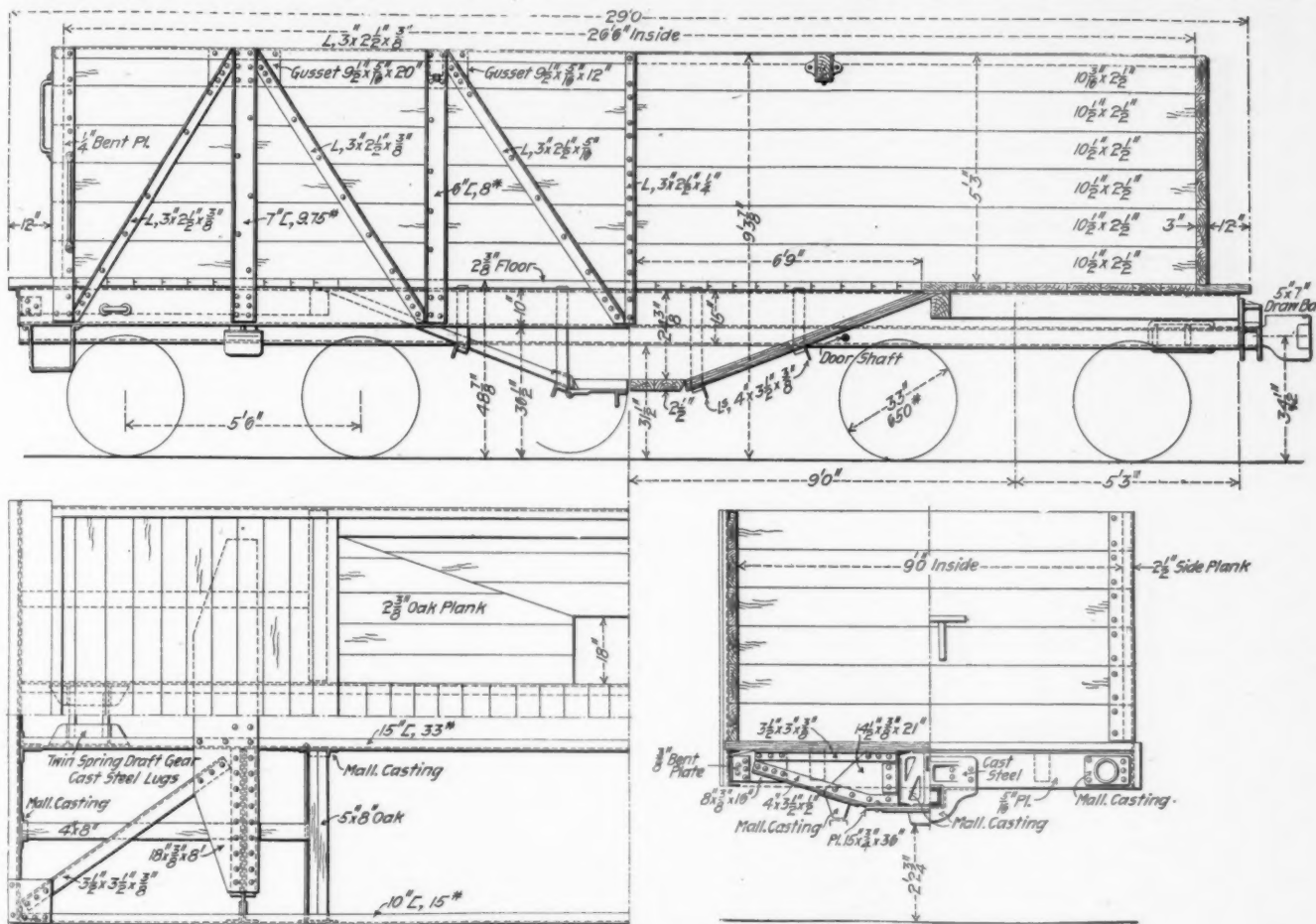
40-TON COMPOSITE GONDOLA COAL CARS.

WITH TRUSSED SIDE FRAMES.

Having had occasion to design a steel frame coal car on the lines of the Pennsylvania class G-N gondola, similar to those in use by the Berwind-White Coal Mining Company, Mr.

steel construction. In this he agrees with those who were responsible for the adoption of composite construction on the Norfolk & Western. In fact, Mr. King says: "The general type of frame follows the lines laid down by Mr. Seley, formerly of the Norfolk & Western. I am frank to say that nothing better has yet come under my observation."

The Norfolk & Western construction was described in this



DESIGN FOR A 40-TON COMPOSITE GONDOLA COAL CAR.

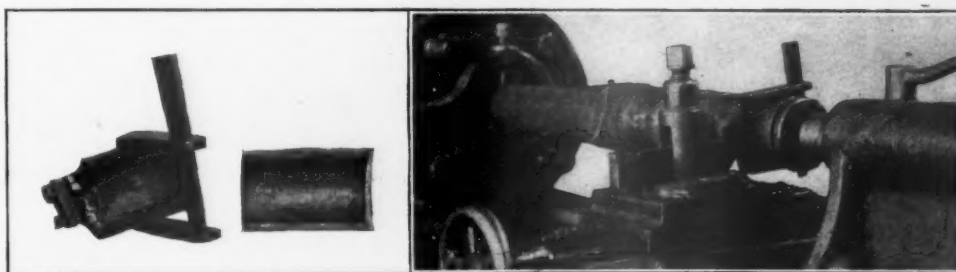
George I. King, of the Middletown Car Works, has sent a drawing showing how easily steel frames may be applied without changing the general dimensions or the trucks. The steel structure is built into or around the wooden structure with a simple substitution of steel for wood in the sills and sides. Instead of pressed steel side stakes, trusses of angles, channels and plates are used. These help to carry the load. The center sills are 15-in., 33-lb. channels; the side sills are 10-in., 15-lb. channels and the end sills are 5-16-in. plates. The drawing shows the construction of the bolsters and side frames and the sizes of the members are indicated. To support the hoppers, 3 by 1 in. straps are used and the floors of the hoppers are stiffened by 4 by 3 1/2 by 3/8 in. angles.

This is not intended as a finished design, but a study in the application of steel in this way. Mr. King believes that the steel frame offers a good many advantages over all steel construction for coal carrying equipment, particularly from the standpoint of corrosion. He is inclined to think that the life of the all-steel car for coal will be much shorter than originally estimated, for reasons which are inherent in the nature of the service. Steel frames with wood sides and floors can be built for less cost than all steel cars and the elements of the structure supplying strength and durability are protected from the scouring action of the coal. If properly painted, when first put in, these members should last much longer than the all-

journal in June, 1899, page 187; April, 1900, page 100; February, 1901, page 42; May, 1902, page 140 and June, 1902, page 181.

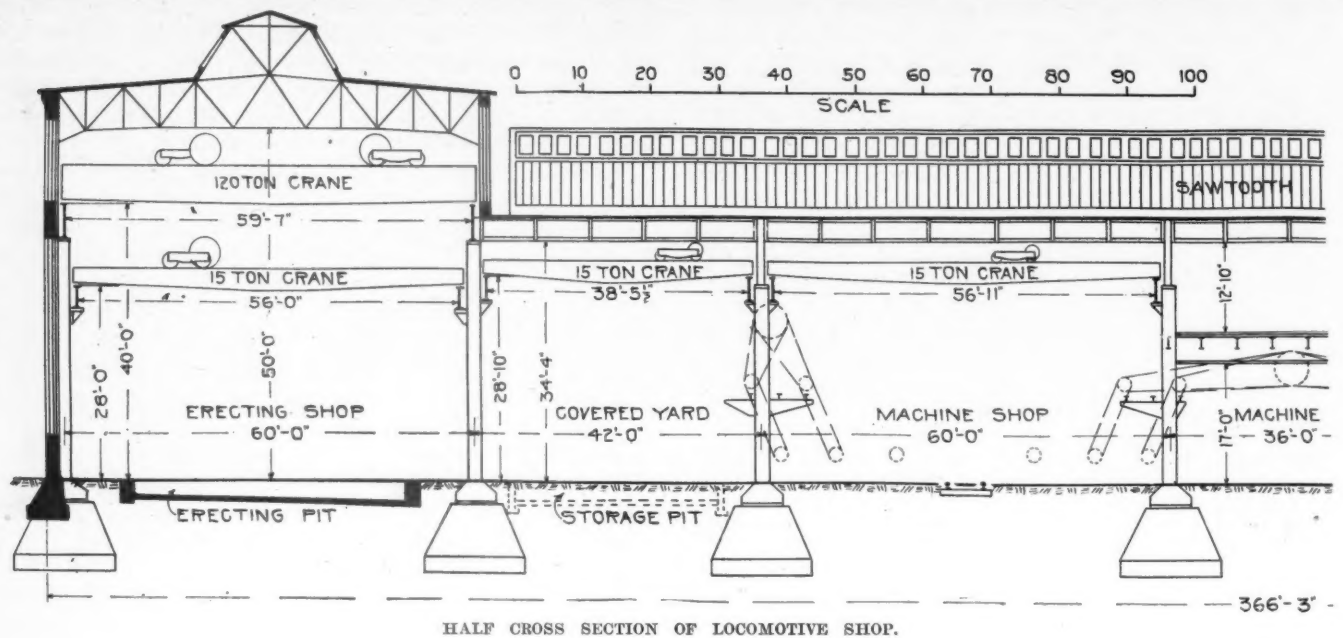
A FILLET TOOL FOR CAR AXLES.

This device was developed by Mr. R. D. Fildes, foreman of the car department machine shop of the Lake Shore & Michigan Southern Railway at Englewood, Ill. It is used to turn up journal fillets when they are worn and the journal itself

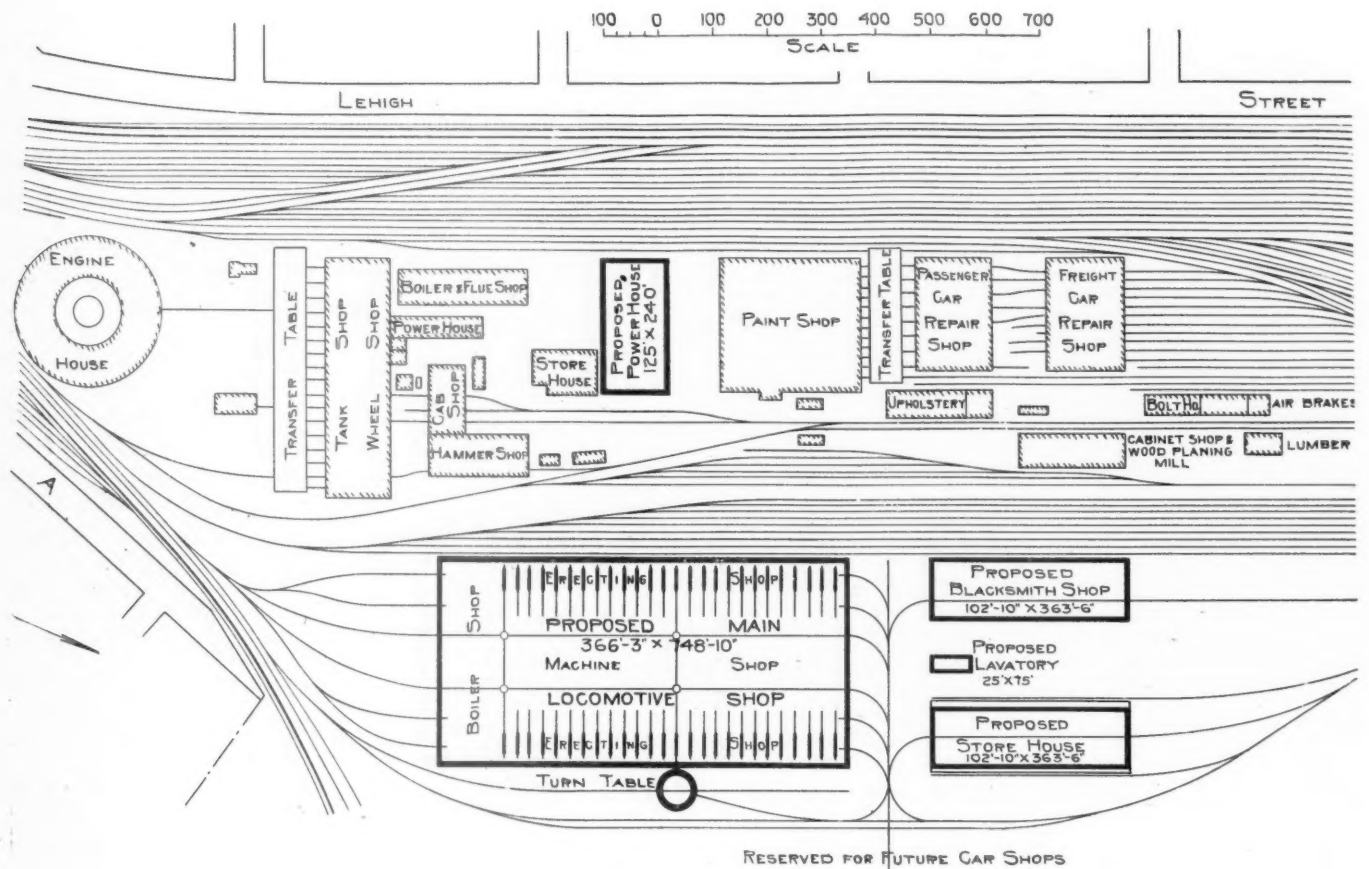


VIEW OF THE FILLET TOOL IN ITS GUIDING SHELL AND METHOD OF APPLYING IN THE LATHE.

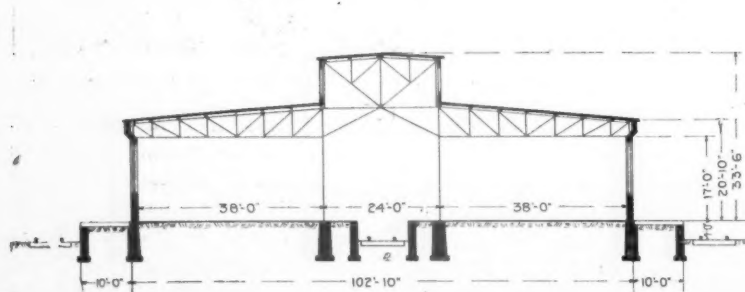
does not require turning. If the journal is worn out of true, even slightly, the fillet cannot be turned up on the lathe without turning up the whole journal as well. This device goes in the lathe and the small tool in one of the halves of the shell, which closely resembles a pair of bearing brasses, is used to turn the fillet, making it true with the journal. The engravings show the shell, the key for holding the two parts in place and the device put together in the lathe ready for service.



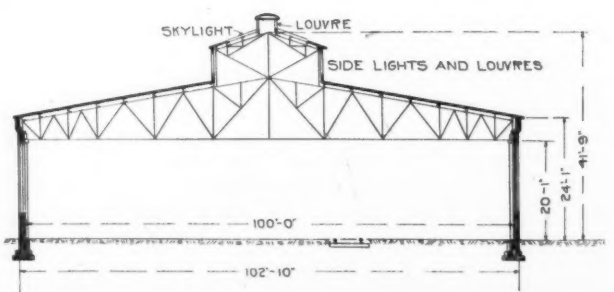
HALF CROSS SECTION OF LOCOMOTIVE SHOP.
PROPOSED NEW SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.



GROUND PLAN OF THE PROPOSED NEW LOCOMOTIVE SHOPS.

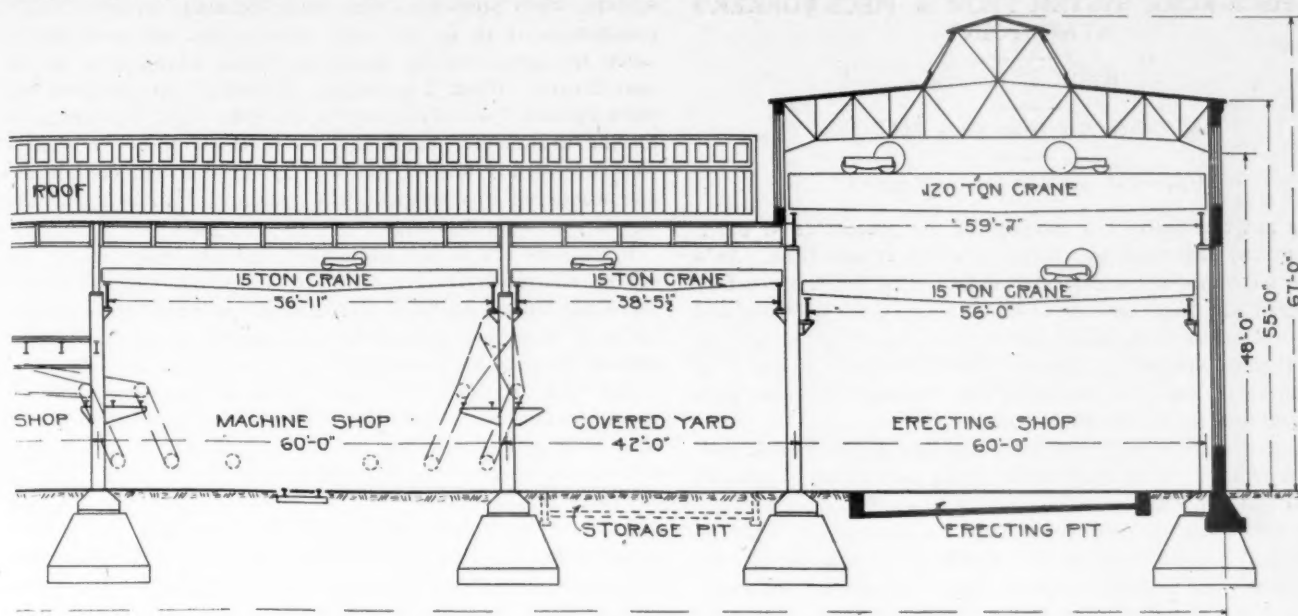


CROSS SECTION OF STOREHOUSE.



CROSS SECTION OF BLACKSMITH SHOP.

PROPOSED NEW LOCOMOTIVE SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.



HALF CROSS SECTION OF LOCOMOTIVE SHOP.

PROPOSED NEW LOCOMOTIVE SHOPS AT SAYRE, PA.—LEHIGH VALLEY RAILROAD.

PROPOSED SHOPS—LEHIGH VALLEY RAILROAD.

AT SAYRE, PA.

A brief statement of the plan for the new shops of this road at Sayre was made last month. Mr. Berg has furnished drawings of the proposed ground plan and sections of the principal buildings, which are presented as indicating the interesting character of the main building. This arrangement gives unique crane service, as shown by the section.

The roof construction of such a building presents an interesting problem. Over the erecting shop bays a monitor with inclined sides will furnish light and ventilation. The roof intermediate between these bays will be of saw-tooth construction and will be supported by columns, as indicated. These columns will furnish supports for countershafting and thus permit of keeping the belting out of the way of the cranes.

The locomotive shop buildings will be the first to be completed. The main locomotive shop will have an erecting shop with 48 erecting pits, divided into east and west sections, each section being 60 x 627 ft. Between the two sections will be the machine shop, 156 x 627 ft. At one end of the building will be the boiler shop, 121 x 366 ft. The machine shop will be divided into two bays, each 60 ft. wide, and a central bay 36 ft. wide. The central bay will have a gallery over it for the heating apparatus, toilets, lavatories, lockers, etc. The space under the gallery will be utilized for small machinery, bench work, link and motion work, tool room, etc. Between each erecting shop and the machine shop there is a 42-ft. space, 627 ft. long, called a covered yard. This space is to be used as an overflow storage ground for both the erecting and machine departments, making a conveniently located space inside the building in place of an open yard outside the building for storage of dismantled parts and miscellaneous materials. In this space will be located the storage pits, lye vats, tire shrinking platforms, etc. This plan gives the result that all locomotive repair work, with exception of blacksmith and forge work, will be conducted in one large building, with overhead cranes serving all important points.

The erecting shop is designed as a transverse shop with heavy overhead traveling cranes for transferring engines over others standing on the pits. This system corresponds to the practice of the most recently built large locomotive repair plants of the Philadelphia & Reading, at Reading, Pa.; the Lake Shore & Michigan Southern, at Collinwood, O., and the Pittsburgh & Lake Erie, at McKees Rocks, Pa.

The capacity of the overhead cranes in the erecting shop will be 120 tons on the upper level and 15 tons on the lower level. The overhead cranes in the machine shop and covered yards will have a capacity of 15 tons. All the cranes will extend into the boiler shop.

The details of the power plant and machinery have not been finally determined. All power transmission and lighting will be by electricity. The machinery in the machine shop will be driven by a combination of individual and group drives.

Ample provision has been made for future extensions and additions, and the new buildings will be grouped in connection with the present buildings so as to give a practical and economically working shop plant. The buildings will generally have concrete foundations, brick walls, steel frame and roof trusses, covered with slag roofing laid on armored concrete. The floors will be generally wood on concrete beds. In the higher grade buildings the top floor will be maple, in other buildings yellow pine. The blacksmith shop and part of the boiler shop will have cinder floors. Side windows will have plain glass and in the main locomotive shop factory ribbed glass. Roof lights and monitor lights will be wired glass. The heating of the main shop will be by a hot air blower system, the fans being run by motors and the heater units supplied with exhaust steam from the power plant. All other buildings will be heated by direct steam radiation. All pipes and main wiring will be conducted from the central power plant through an underground tunnel and ducts to the various buildings. Proper provision will be made for water supply, fire service, drainage, sewerage, sanitary arrangements, etc.

The design, construction and equipment of the new shops will be in charge of Walter G. Berg, chief engineer, and H. D. Taylor, superintendent motive power.

The British Westinghouse Company are building for the Metropolitan District Railway of London four turbo alternators, each having a normal capacity of 5,500 kw. and designed for 50 per cent. overload, which will give a maximum capacity of 8,250 kw., or approximately 11,000 h.p. each. These will be the largest turbines ever built, and no larger single-cylinder engines have ever been constructed. In fact there are few engines of any kind having greater power. The space occupied by each unit will be 29 x 14 x 12 ft. high. The turbines will operate with steam at 165 lbs. per square inch and will make 1,000 revolutions per minute.

THE PIECE-WORK SYSTEM FROM A PIECE-WORKER'S STANDPOINT.

By H. B. KEPNER.

(Concluded from page 233.)

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It is not the desire nor purpose of the promoters of piece-work to pay less than any work is worth at any time. As a master mechanic of considerable note and experience recently instructed his inspector not to be obstinate with his men and "in any dispute of a small difference of, say, three or four cents, though you may be sure he is not entitled to it, yet if he believes he is, pay him and always in a matter of doubt, give the workman the benefit of the doubt."

Does this instruction from the promoters of piece-work look as if they desired to oppress or grind down the workman? And do you think that his men would wilfully take advantage of his fine sense of justice, even to the amount of three or four cents? I should answer, no. For being a workman of long association with workmen, I know there is too much of genuine worth in the make-up of even the most ordinary shop man to ignore such kindness. And would you censure the master mechanic as being partial towards the interests of the men? Again I would answer, that he is most loyal to the interests of his employer when he is most solicitous as to the welfare of his workmen. For he is thereby meriting their highest esteem and drawing from them the best there is in them, both in service and manhood.

But I would be digressing to go further than this, to illustrate that it is illogical to expect less fair treatment under the piece-work system than is received under the day-work system. When the workmen are once convinced that they are to be treated with justice in every respect, the dread of piece-work will vanish and the men will feel freer to put forth their best efforts and quit worrying about the reduction of prices, but instead will be ready with suggestions as to their adjustment until, as water seeks its level, prices will gradually become fixed at a fair and equitable standard. The men themselves will assist in regulating prices, conceding to adjustment of prices that are too high as often as the inspector may, in cases where prices are too low.

A case recently came under my observation where an inspector, working upon the plan of starting in on low prices, undertook to install piece-work into a department of wood-workers and set a price at about half of what the foreman of that department asked, and rather than concede to the workman's reasoning, declared that the work was done for a certain amount at an Eastern factory and that he would only pay so much here, resulting in a strike and failure to establish piece-work in that department.

Now, in introducing piece-work into a shop, it is preferable to retain the old force of workmen and avoid unnecessary clashing with them, if possible, though they may sometimes seem to jump at conclusions and appear unreasonable. It is not merely of choice that they are obstinate in their views, but through distrust, which is strengthened by every decision on the part of the inspector or foreman, contrary to their views or their rights, as they understand them.

A large body of men who have not the time or opportunity, or possibly not the inclination, to give the subject the thorough investigation it deserves may be influenced and led by the views expressed by one of their number, though he may have little or no ground for his theories and may be incited through prejudice to agitate his fellow-workmen to act in a united effort to prevent its adoption.

And yet, after a careful study and a thorough trial, I have seen the most obstinate change their minds, and men who had most vigorously opposed piece-work became convinced of its fairness. They lost all fear of dishonesty on the part of its promoters and just as vigorously protest against a change back to the day-work system.

Several years ago, before the Burlington roads adopted the

system, when piece-work was being debated, my own brother pronounced it to be the only just method of compensating labor and predicted its almost universal adoption in no distant future. When I attempted to defend the common day-work system, I was surprised at the difficulty I experienced in finding arguments commendatory to the system. I admit I was successfully floored, against my most ardent contentions, and wondered why it was. The system is still being debated and is yet in its infancy.

Price lists are being established, though under many difficulties, and much uncertainty as to fair prices is bound to exist for some time yet, until all branches of shop work may be properly classified and correct estimates of time and labor derived through various experiments and observations.

The task of establishing prices is an important one and should be met fairly and squarely from every standpoint. The rates paid in Philadelphia, for instance, should of necessity be a little closer than they are out here in the West, for are not day rates less there than they are here? Then again, the prices there have been fixed after years of experimenting and developing facilities for doing the work until their prices may look incredulously low and men out here will conclude they are to lose if they submit to them, and probably with the present facilities they would. But rather trust the workmen who make an honest effort to demonstrate the most reasonable time required to do the work and pay accordingly. If too great a difference exists investigate the cause, compare facilities, remembering that you have just as good men as they have anywhere, and with facilities and conditions the same like results may be obtained.

I believe any body of workmen who are competent and fair can be shown that greater possibilities are open to them under the piece-work system than any other, that they can make more money, and that their employers can always afford to pay them better than they ever did under the day system.

PISTON VS. SLIDE VALVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

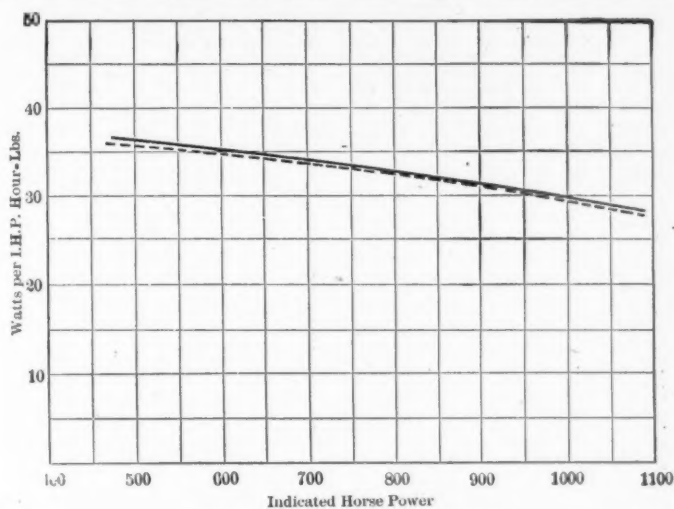
Last October this road conducted an elaborate series of tests to determine the relation of piston and Richardson slide valves with respect to water consumption, 18 tests being made with the piston valve and 20 with the slide valve.

The two engines used were of the 4-6-0 type, identical in every respect as to the valve motion, No. 600 being equipped with the Allen-Richardson balanced slide valve while No. 611 had the direct motion, inside admission, piston valve, the principal dimensions being 20 x 28-in. cylinders, 80-in. driving wheels, weight on drivers 133,000 lbs., total weight 171,600 lbs., heating surface 2,862 sq. ft., grate area 33.5 sq. ft. The tests were made on the Michigan Southern division—143 miles long—Elkhart to Toledo and return, and on two regular mail trains, nothing out of the ordinary as to speed or methods of firing in any way being attempted, as the tests were made to get results from ordinary every-day practice. Two engine crews were practically all that were used during the whole test, the tonnage and speed of the trains, also the weather, did not vary much from day to day, and everything was conducive to an accurate test. (The locomotives were described in *THE AMERICAN ENGINEER*, November, 1899, page 343.)

To determine the indicated horse-power indicator cards were taken every minute throughout the runs. The speed was taken by a revolution counter which was checked by mile posts and found correct. Water measurements were taken by gauges placed in the corners of the tank, the readings being corrected to give the depth of the center of gravity of the surface of the water. By subsequently calibrating the tank for each inch of height, on track scales, this method of measurement was checked. Coal was weighed on the tender by track scales. Eighteen tests were made on engine No. 611, these being equally divided on each side of the engine, 20 runs being

made with the other engine. No allowance was made for the steam consumed by the air pumps, the loss at pop valves or water lost at the injector overflows. The indicated horsepower was averaged as given in the accompanying table. For several of the runs the cylinder tractive power was plotted, and the total foot-pounds of work were found from the diagram, but it was found to vary so little from the average indicated horsepower that the latter was used in subsequent tests. The indicated horsepower was taken only for the time during which steam was applied.

The results are clearly shown in the diagram, illustrating the relative efficiency of the two engines far better than the tables. The dotted curve on the diagram is that of engine No. 611, with the piston valves. These curves are interesting because they show remarkably uniform results from road tests, and there is little doubt of the accuracy of the curves drawn to represent the average results. The piston valve engine is



DATA FROM INDICATOR CARDS.

(DOTTED CURVE REPRESENTS THE PISTON-VALVE ENGINE, AND SOLID CURVE THE SLIDE-VALVE ENGINE.)

slightly more economical than the one with slide valves, but by amounts varying only from 1 to $1\frac{1}{2}$ lbs. of water per h.p. per hour, say 3 to $4\frac{1}{2}$ per cent. This is probably due to decreased compression in the piston valve engine which is shown in the indicator diagrams. The indicator diagrams show that the steam line is better maintained on the slide valve engine, the exhaust line being, however, better on the piston valve engine.

The tests are interesting also from the large amount of power developed, each engine having averaged over 1,000 h.p. for the entire distance of 143 miles. The evaporative efficiency is low and the reason for this is not yet determined. The coal burned per foot of grate is high, and it is evident that the work developed is all that could be expected from the engines.

PISTON VS. SLIDE VALVES.

Average Results.

	Piston.	Slide.
Engine number	611	600
Duration of steam in minutes.....	161	155
Tonnage behind tender.....	317	327
Ton miles	45,400	46,700
Average speed, deducting stops.....	50.0	49.2
Ton (miles per hour).....	15,400	16,100
Average indicated horsepower.....	838	795
Horse power hours.....	2,160	1,990
Total coal	13,430	13,600
Total water	68,400	69,430
Water per pound coal.....	5.33	5.10
Water per horse power hour.....	31.7	34.9
Water per ton mile.....	1.51	1.49
Water per ton miles per hour.....	4.16	4.30
Coal per horse power hour.....	6.23	6.83
Coal per ton mile.....	.296	.291
Coal per ton miles per hour.....	.872	.845
Water per square feet heating surface hour.....	9.23	9.27
Coal per sq. ft. grate area per hour.....	143.	162.5
Average tractive pull from cards.....	5,680	5,480
Average cut off in inches.....	8.52	7.49
Average opening of throttle.....	.157	.123

The speed at which any machine tool can be successfully run is limited only by the burning of the cutting tool, and the greatest production is obtained by running as near this point as possible.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

VII.

BY C. W. OBERT.

An interesting example of the application of variable-speed gear-drive mechanisms to machine tools is presented in a new series of designs of the milling machines built by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. The LeBlond Company have recently entirely redesigned their line of milling machines in order to meet the very exacting conditions imposed by the use of the new special heavy-duty tool steels in the great tendency toward increased production. Particular care has been exercised in the new designs to provide sufficient strength in the various parts to withstand the "pull" of the heavy cuts, and two important new features have been incorporated, namely, a double back-gear with a special friction clutch, and a very interesting change-gear mechanism for the feeds.

The feed-change mechanism involves an interesting adaptation of the cone of gears and shifting pinion principle. Unlike other devices for this purpose, which we have discussed, this mechanism has two gear cone arrangements, one of which is adjustable in two directions and the other fixed in position, thus permitting a large number of gear combinations with a minimum number of parts. The arrangement for bringing the movable gear cone into mesh with the fixed cone for the various speeds is of particular interest for its simplicity.

The gear box, an exterior view of which is presented in Fig. 32, is mounted at the rear of the right hand side of the milling machines frame, as shown at F, Fig. 31, for convenience of connecting the drive from the spindle. The drive is through spur gearing, arranged within the frame of the machine and so placed as to deliver power to the driving shaft, S, by meshing with gear, A.

Fig. 33 is a cross-section through the middle of the gear box, F, so as to show the relative positions of the various gears and gear cones, and Fig. 34 indicates diagrammatically the principle of the drive. In the latter drawing the drive is shown passing from the driving shaft, S, through gears, A-b-a-k-g-O, to the delivery shaft, T; cone of gears, P, is movable, however, and is thus capable of being placed in any necessary position for the possible gear combinations with fixed cone, Q.

Cone, P, is mounted, as shown in Fig. 33, upon a rocker frame, R, which frame is pivoted loosely upon delivery shaft, T. Gear, g, of cone, P, is arranged so as to be permanently in mesh with a gear, O, which is feathered to shaft, T, and is spanned by frame, R, so as to permit longitudinal movement along the shaft while revolving with it. As will be seen from Fig. 34, eight gear combinations are possible, for which reason eight locking holes are provided on the front of the gear box. Handle, H, of the rocker frame is correspondingly provided with a spring pull pin, which is arranged to drop into a locking hole for each position of proper meshing.

It may be noticed from Fig. 34 that there is absolutely no possibility of any interference, or of double-meshing combinations, in shifting the rocker frame, R. From the way that the movable and fixed cones are arranged in the gear box it is impossible to bring more than one pair of gears into mesh at the same time, so that no guiding arrangement is necessary for the locking handle, H; this is an important feature of this mechanism, in providing against stripping gear teeth.

In addition to the eight speeds thus made available, another eight speeds are provided for by the shifting gear arrangement on shaft, S. By throwing the clutch handle shown on the upper side of the box the pair of gears, A-B, which are mounted rigidly upon a sleeve sliding freely upon shaft, S, may be thrown over to one side or the other, so that either one may drive cone, Q, through corresponding gears, and thus at either a fast or a slow speed. Each handle on the gear box is en-

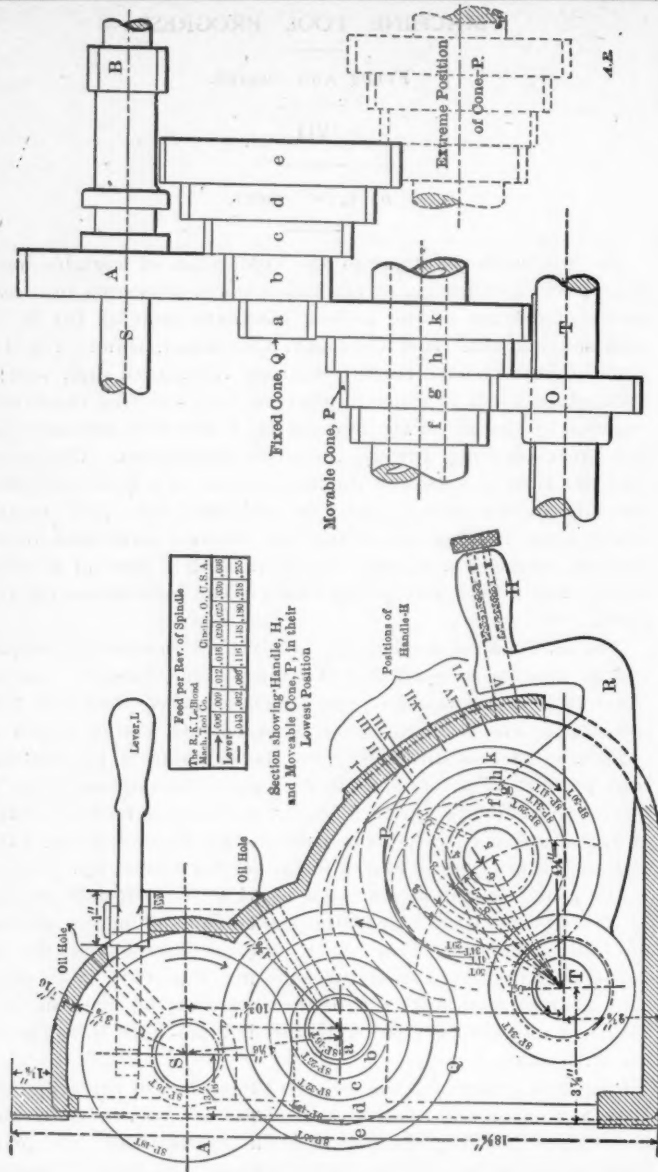


FIG. 33.—CROSS SECTION OF GEAR BOX, SHOWING ARRANGEMENT OF GEAR CONES.

FIG. 34.—DIAGRAM ILLUSTRATING PRINCIPLE OF THE GEAR BOX DRIVE.

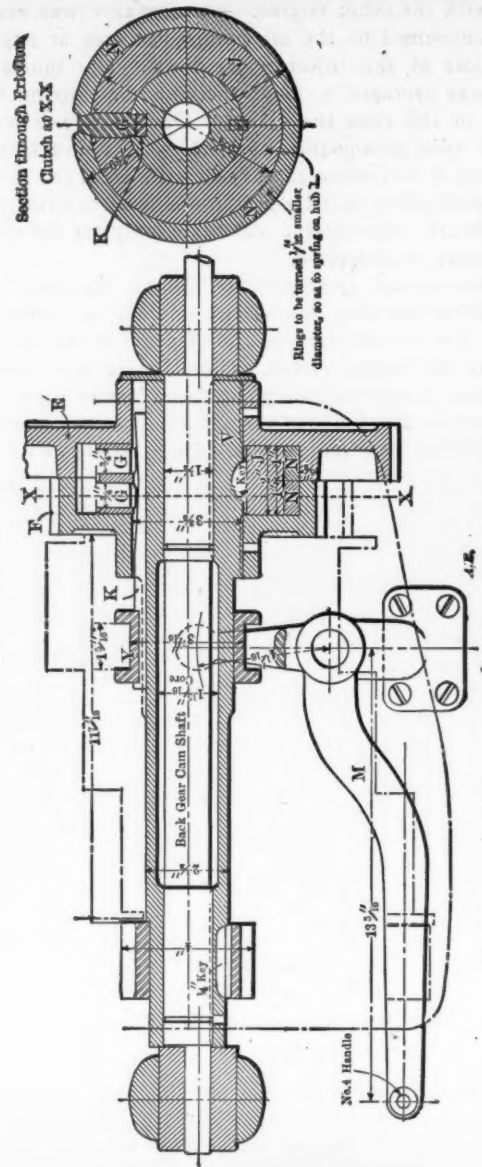


FIG. 35.—DETAILS OF THE FRICTION CLUTCHES FOR THE DOUBLE BACK-GEAR.

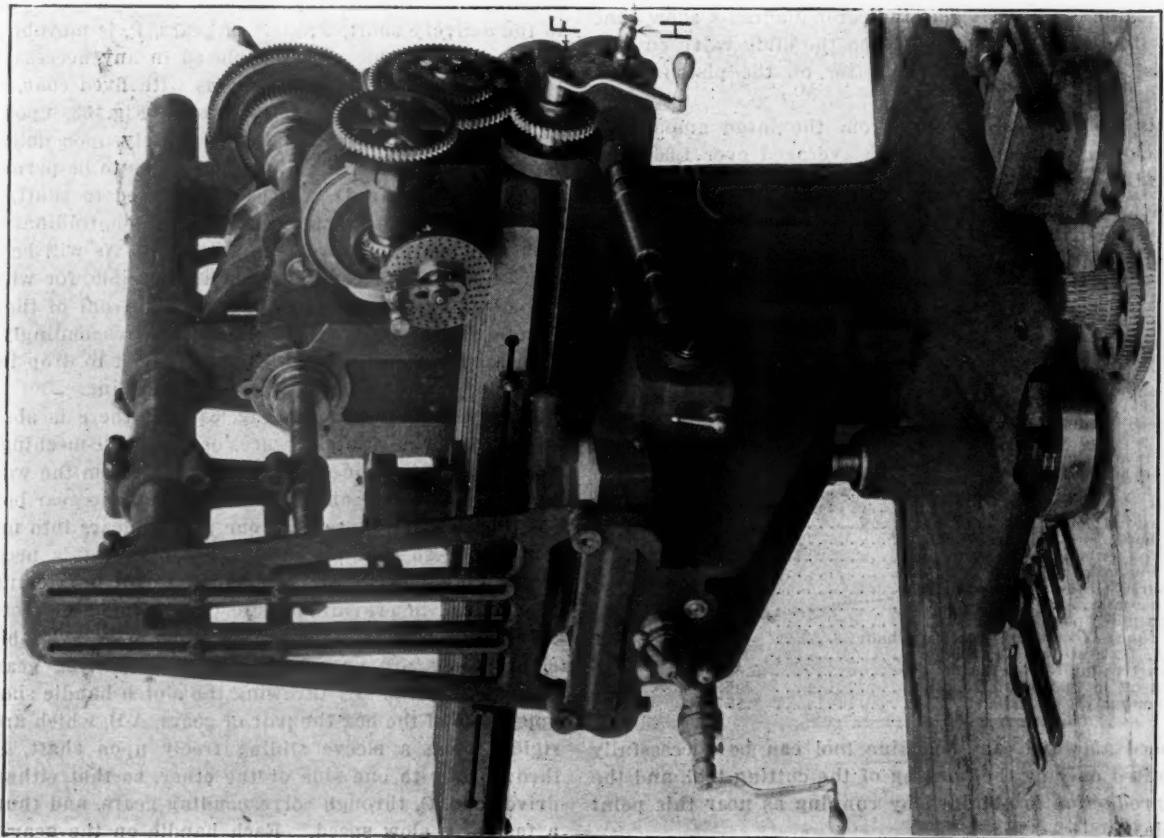


FIG. 31.—GENERAL VIEW OF THE NEW NO. 3 MILLING MACHINE.

NEW UNIVERSAL MILLING MACHINE.—THE R. K. LEBLOND MACHINE TOOL COMPANY.

tirely independent of the other—they may be operated separately or in unison.

The feeds are arranged in geometrical progression, ranging from .006-in. to .225-in. per revolution of the spindle. An engraved plate (reproduced in Fig. 33) is attached to the feed box which indicates the feeds obtained for each position of the handles. When the upper lever is thrown to the right, all the finer feeds are obtained, ranging from .006-in. to .036-in., which is the range generally used with the direct cone drive without the back gears; when the upper lever is thrown to the

These plugs, which have tapering sides, are forced up by the double taper key, K. The friction rings are made to snap tight on the spool, J, so that when the plug, G, is withdrawn, the ring fits tightly on the spool, centering itself and relieving the gear of all friction. The wedge action of the key is carried by yoke, Y, which in turn is moved by the lever, M, shown at the side of the column.

The special advantage of applying the friction clutch at this point is that, on account of its high speed, its power is multiplied a good many times before it reaches the spindle, as the

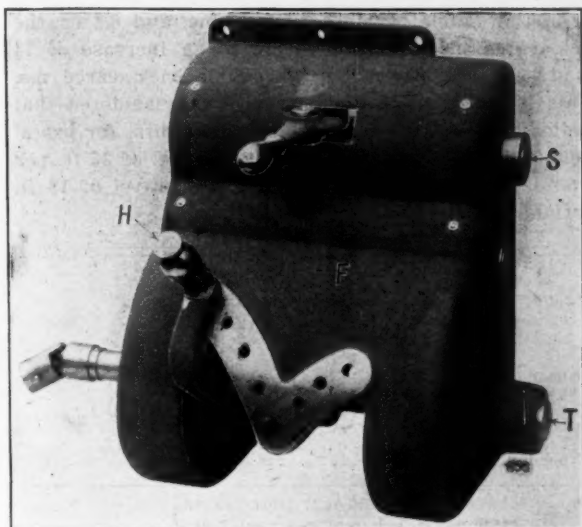


FIG. 32.—EXTERIOR VIEW OF 16-SPEED FEED GEAR BOX.

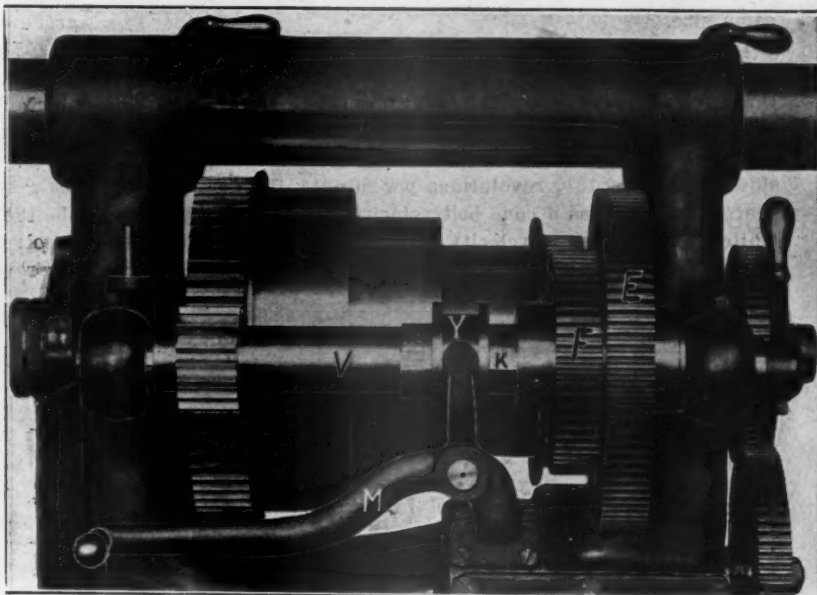


FIG. 35.—VIEW OF DOUBLE BACK-GEAR ATTACHMENT, SHOWING HANDLE FOR OPERATING THE FRICTION CLUTCHES.

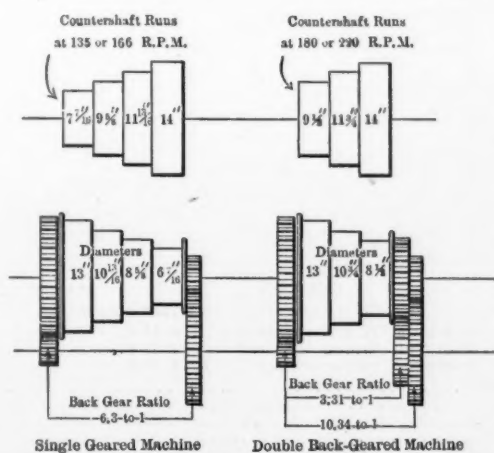


FIG. 37.—BACK-GEAR RATIOS FOR SINGLE AND DOUBLE BACK-GEARED MACHINES.

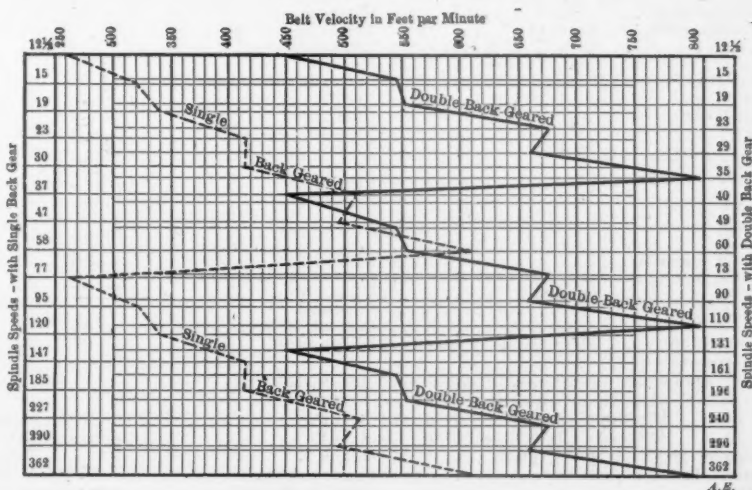


FIG. 38.—DIAGRAM SHOWING INCREASED BELT VELOCITY PROVIDED IN THE DOUBLE BACK-GEARED MACHINE.

left, the coarser feeds are obtained, ranging from .043-in. to .225-in., for use when the spindle is back geared. These speeds are proportioned inversely to the spindle speeds, thus obviating all feeding speeds that are detrimental to the machine.

The double back-gear arrangement for multiplying the driving speeds available from the cone involves a very interesting construction. This attachment is illustrated in Fig. 35, and is shown in detail in Fig. 36. Gears, E and F, revolve loosely upon the back-gear sleeve, V, when the back-gear is thrown in; for throwing either one of them in gear a double-throw taper key is provided, as shown at K, which will operate friction clutches to throw either gear into operation, but never both. In this way the back-gear furnishes two extra runs of speeds instead of one, as is the usual arrangement.

The friction clutches consist of the rings, N, within their respective gears, E and F, which are opened by the plugs, G.

clutch drives the back-gear pinion, which in turn drives the face gear. This makes it several times as powerful as would be a clutch direct in the face gear. It also enables the friction clutch to be carried under light tension, as well as permitting a better proportioned cone and higher belt speeds and better belt contact.

A very interesting comparison has been made by the Le Blond Company, showing the relative spindle power of a double back-gear machine as compared with that of the ordinary single back-gear machine, for similar conditions in both instances, which clearly shows the superiority of the former. For examples a double back-gear drive and a regular single back-gear drive were compared, as indicated in Fig. 37, both of which had been calculated to give the same range of spindle speeds, from 12½ to 262 revolutions per minute. The countershaft on the double-gear machine runs at 180

and 220 revolutions per minute, while that on the single runs at 135 and 166 revolutions per minute, giving the double-gear machine a gain in power of 33 and 30 per cent., respectively, for the same size of belt. The cone diameters on the double-gear machine are 13, 10 $\frac{1}{4}$ and 8 $\frac{1}{2}$ ins., while on the single-gear machine they are 13, 10 $\frac{1}{4}$ and 8 $\frac{1}{2}$, and 6 $\frac{1}{2}$ ins. in diameter; this gives an increased diameter on the smallest step of the cone of the double back-gear machine of 2 $\frac{1}{2}$ ins., amounting to 32 per cent. increase of belt contact. This pertains as well to the small step of the countershaft cone, as the spindle and countershaft cones have their largest steps of the same size.

To illustrate this more fully a diagram is presented in Fig. 38, showing graphically the belt velocity in feet per minute on the two machines. The broken line represents the single-gear machine and the solid line the double back-gear machine. It will be seen that when the two machines are running at the slowest speed of 12 $\frac{1}{2}$ revolutions per minute, the double back-gear machine has a cone belt velocity of 447 ft. per minute, while the single has a velocity of 267 ft. per minute, showing a gain for the double back-gear machine of 70 per cent. in

power. This proportion of gain is maintained until a speed of 35 revolutions per minute is reached when, upon engaging the low ratio of the back gear, the belt speed of the double back-gear machine is reduced to about that of the single-gear machine; from this point on, however, the belt speed increases until at 75 revolutions per minute, there is a difference in belt travel of 390 ft. per minute, with a gain of 150 per cent in power.

There is still another feature to consider that has important bearing on the power of machines, namely: the ratio of back gear. Calculating the ratio of back-gear so as to give an even grade of speeds running in geometrical progression from 12 $\frac{1}{2}$ to 362 revolutions per minute we get a back-gear ratio of 3.31 and 10.34 on the double back-gear machine, and 6.2 on the single back-gear machine, amounting to an increase of 74 per cent. in back-gear power for the double back-gear machine. This is better understood when it is considered that for a spindle speed of 12 $\frac{1}{2}$ revolutions per minute, for example, the double back-gear would have a belt travel of 35 ft. per revolution, the single of 22, or a gain in belt travel of 13 ft. per revolution.

POWER TEST OF GROUP DRIVE MOTORS.

RECORDS OF POWER REQUIRED FOR THE GROUP DRIVES AT THE ROANOKE SHOPS.

NORFOLK & WESTERN RAILWAY.

(Conclusion of the Tool List from Page 223.)

Diagrams presenting graphical records of the tests made upon these groups are to be found on page 223 of the preceding (June 1903) issue of this journal.

GROUP NO. 8.—25-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 30.7 H.P.
Minimum power required = 12.2 H.P.
Average power required = 18.4 H.P.

Univ. boring mill.....	37 ins.	Niles.
Univ. boring mill.....	37 ins.	Niles.
Shaper	12 ins.	Bement & Son.
Planer	36 x 36 ins.	Sellers.
Lathe	18 ins.	Niles.
Drill press	32-in. table	Prentice Bros. Co.
Milling machine		Brainard.
Drill press	18-in. table	Prentice Bros. Co.
Planer	30 x 30 ins.	Sellers.
Emery wheel	12 ins.	Bement, Miles & Co.
Shaper	12 ins.	Bement, Miles & Co.
Planer	36 x 36 ins.	Sellers.
Lathe		
Hor. boring machine.....	No. 2 $\frac{1}{2}$	Niles.
Drill press		
Hor. boring machine.....		Niles.
Hor. boring machine.....		Bement & Son.
Slotter	18 ins.	Niles.
Nut facer		Newton.
Drill press		Bement & Son.
Testing machine	200,000 lbs. capacity	Riehle Bros.

GROUP NO. 9.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 34.1 H.P.
Minimum power required = 10.6 H.P.
Average power required = 15.4 H.P.

Driving-wheel lathe	80-in. plate	Sellers.
Truck-wheel lathe	24 ins.	Bement & Son.
Key seater		Miles & Merrill.
Lathe	18 ins.	Pond.
Driving-wheel lathe	84-in. plate	Niles.
Lathe, extension	14 ins.	Harrington & Son.
Lathe, extension	15 ins.	Sellers.
Driving-wheel lathe	60 ins.	Niles.
Planer	30 x 30 ins.	Harrington & Son.
Lathe	18 ins.	Niles.
Vert. boring mill.....	51 ins.	Niles.
Planer	30 x 30 ins.	Harrington & Son.
Walking crane		

BOILER AND ERECTING SHOP.

GROUP NO. 11.—25-H.P. C. & C. MOTOR.

Maximum power required = 20 H.P.
Minimum power required = 15.4 H.P.
Average power required = 18.2 H.P.

Emery wheel		
Lathe	7 ins.	Grant & Bogert.
Drill press	12-in. table	
Drill press	26-in. table	Prentice Bros.
Staybolt cutter		Blair.
Staybolt cutter		Blair.
Radial drill press.....		Kelly & Ludwig.
1 shear and punch.....		Long & Alstatter.
1 shear and punch.....		Long & Alstatter.
4-spindle drill		Bement & Son.
Plate planer		Dunkirk Iron Works.
Horizontal punch		Long & Alstatter.
Blower	No. 33	Sturtevant.
Rolls	No. 5	Niles.

SMITH SHOP AND FLUE ROOM.

GROUP NO. 13.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 12.3 H.P.
Minimum power required = 2.9 H.P.
Average power required = 9.1 H.P.

Small bolt header.....		
Small bolt header.....		
Small bolt header.....		
Large bolt header.....		
Large bolt header.....		
Large bolt header.....		

GROUP NO. 15.—50-H.P. EDDY MOTOR.

Maximum power required = 60.3 H.P.
Minimum power required = 39 H.P.
Average power required = 52.3 H.P.

Fan	No. 10	Sturtevant.
Flue welder		
Flue welder		
Flue cutter		

GROUP NO. 17.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 19 H.P.
Minimum power required = 4.4 H.P.
Average power required = 12.4 H.P.

Shears		
Shears		
Bolt cutter, D. H.....		Acme.
Bolt cutter, D. H.....		Acme.
Bolt cutter, D. H.....		Acme.
Bolt cutter, D. H.....		Acme.
Bolt cutter, D. H.....		Acme.
Bolt cutter, S. H.....		R. M. W.
Bolt cutter, D. H.....		Acme.
Bolt cutter, S. H.....		R. M. W.
Nut tapper		Howard Bros.

FOUNDRY.

GROUP NO. 18.—20-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 13.8 H.P.
Minimum power required = 5.4 H.P.
Average power required = 10.4 H.P.

2 rattlers (small).....		
Fan (small)		
Brass borer		
2 emery wheels.....		

GROUP NO. 19.—15-H.P. GENERAL ELECTRIC MOTOR.

Maximum power required = 16.2 H.P.
Minimum power required = 4.2 H.P.
Average power required = 11 H.P.

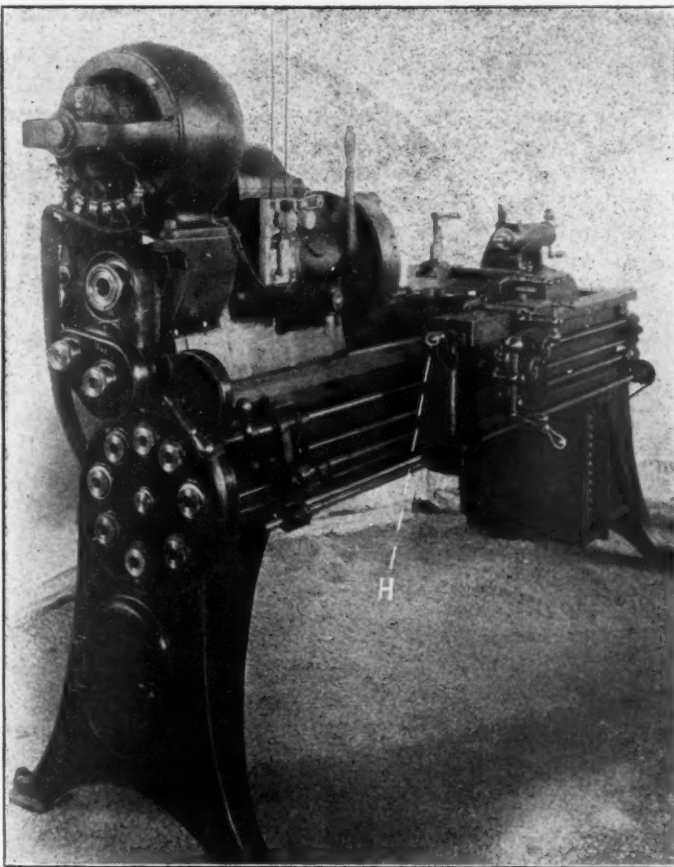
1 rattler	6 ft. 6 ins. long.....	
1 rattler	4 ft. long.....	
2 double emery wheels.....		

The Endura Company, Limited, 92 Griswold street, Detroit, Mich., have issued a circular describing Endura Coating and illustrating an overhead bridge of the New York Central at Mott Haven, New York, which was protected with it two and a half years ago. It includes a letter from Mr. Olaf Hoff, engineer of structures of the road, stating that the paint was in good condition after two years of service. This paint is specially intended for the protection of metallic surfaces. It supplies an elastic, flexible protection with a heavy body and excellent adhesive qualities, and is advocated as a preservative for steel cars. The pamphlet also contains letters from J. S. Culver, president of the Culver Construction Company, Springfield, Illinois; George I. King, manager steel car department of the American Car & Foundry Company, and W. E. Nichols, purchasing agent of the Pacific Coast Company.

A NEW DESIGN OF ELECTRIC DRIVE FOR THE IDEAL LATHE.

SPRINGFIELD MACHINE TOOL COMPANY.

A very interesting motor drive application has recently been designed by the Springfield Machine Tool Company, Springfield, Ohio, for use upon their well-known "Ideal" engine lathe. The method of mounting the motor upon the headstock, which is used, is an entirely new departure in motor driving. The headstock arrangement has been entirely redesigned to accommodate the gearing and connections for the drive, so that as a result the motor actually appears to form an integral part of the lathe's construction and does not give the impression of being an after consideration.



A NOVELTY IN ELECTRIC DRIVING FOR THE "IDEAL" LATHE.—SPRINGFIELD MACHINE TOOL COMPANY.

The accompanying view illustrates the new drive upon their 16-in. x 8-ft. Ideal lathe, two of which lathes have been furnished, thus equipped, to the Northern Electrical Manufacturing Company, Madison, Wis. This lathe was, as will be remembered, described on page 157 of our May, 1902, issue, and also with particular reference to its novel rapid feed-changing mechanism, on page 27 of our January, 1903, issue. The motor is mounted directly upon a pair of lugs cast integral with the headstock, from which position it drives direct to the spindle through gearing. The drive is through a reduction gearing to an intermediate slip-gear shaft, which may drive the spindle at either of two speeds. The slip gears are controlled by a handle on the gear case at the right of the motor, so that either run of gears may easily be thrown in. These two runs of gears are supplemented by the usual back gear attachment, making four different speeds available by gearing.

The motor, which is a $1\frac{1}{2}$ -h.p. variable-speed direct-current motor, made by the Northern Electrical Manufacturing Company, operates on the two-wire system, the speed control being obtained by field resistance control, which gives a varia-

tion at the armature shaft of from 600 to 1,200 revolutions per minute, or 2 to 1. The motor controlling rheostat is located inside of the legs beneath the right-hand end of the lathe's bed and is operated, through the agency of a splined shaft and sprocket chain, from the carriage. The handle, H, on the carriage operates through a sliding gear on the splined shaft so that the motor is under control, no matter what position the carriage is in.

This arrangement of driving is worthy of careful consideration for its extreme compactness, yet great flexibility, as it gives a total spindle speed range of from 6 to 310 r.p.m., by both electrical and mechanical speed changes. This is a firm step toward a rational design of motor driving, inasmuch as a very wide speed range is obtained, and with a large number of steps, yet with no irregularities of either lathe or motor design.

BOOKS AND PAMPHLETS.

Steam Power Plants; Their Design and Construction. By Henry C. Meyer, Jr., M. E.; 160 pages, 8 vo., cloth; 16 folding plates and 65 figures in the text. Published by the McGraw Publishing Company, 114 Liberty street, New York. Price, \$2.00.

This is a work of exceptional value to all interested in power plant construction or design. It is an elaboration of a series of articles by the author which originally appeared in the *Engineering Record*, and which were intended for engineers in charge of machine shops who are called on to design and purchase a steam-power plant or parts of it when their knowledge of the machinery that goes into such a plant is more or less limited, and when they are not able to obtain the advice of a competent consulting engineer. The book as a whole is well written and contains a great deal of valuable information in a small space. The power-plant engineer will find little in it that is entirely new, but he will find much that is worth his attention as a reminder of the many things that have to be considered in designing. To such engineers perhaps the most useful part of the book will be the sixteen folding plates, most of which are ground plans and sectional elevations of recent plants, showing the location of boilers, engines, piping, etc. This volume contains much valuable data in accessible and convenient form.

Modern Machine Shop Tools. Their Construction, Operation and Manipulation. By Wm. H. Van Dervoort, M. E.; 552 pages, profusely illustrated with 673 engravings; 8 vo., cloth. Published by Norman W. Henley & Co., 132 Nassau street, New York. Price, \$4.00.

This is a practical treatise on general machine shop practice, and is especially important on account of being brought right up to date in all details. The subjects are treated in a clear and comprehensive manner and are intended to serve as a text-book for the apprentice and also as a convenient reference volume for the machinist and shop foreman. The work begins with a treatise of the hammer and cold chisel, filing, scraping, etc., and of all the ordinary hand tools, after which gauges, indicators, etc., are considered, followed by several chapters on drills, reamers, taps, dies, mandrels, etc. The remaining portion of the volume treats of the various machine tools, and various processes of grinding and hardening and tempering. Special mention should be made of the excellent treatment of the subject of grinding. This work is of great value to all interested in machine shop practice and we heartily commend it for their use.

A. Leschen & Sons Rope Company, 920 North First street, St. Louis, have issued a new catalogue No. 24, describing the wire rope and cordage of every description manufactured by them. Their flattened strand wire ropes are specially noteworthy because of being free from tendencies to spin or kink, and because of their large wearing surfaces. Those requiring wire rope and fittings, blocks and accessories or rope tramway equipment will find all necessary information in this catalogue, which may be had upon application at the offices of the company.

A list of users of the Reynolds-Corliss engines has been issued by the Allis-Chalmers Company, containing a partial statement of the locations of engines of this type built by that company at their Milwaukee works. Eighteen pages are occupied by the index of States and cities in which the engines are located. The list covers 190 pages and gives the size of each engine. It is a magnificent record and exhibit of the esteem in which the product of these works is held.

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are especially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

THE CONVENTIONS.

It will be necessary to reserve our comments upon the three important conventions which have just closed at Saratoga until next month on account of the unusually late date at which they were held this year. We have, however, been enabled to present abstracts of several of the papers and also the discussions at the Master Mechanics' and Master Car Builders' conventions.

LOCOMOTIVE TESTING PLANT AT THE ST. LOUIS EXPOSITION.

A locomotive testing laboratory is to be operated in the transportation department of the approaching exposition at St. Louis. Mr. Willard A. Smith, chief of that department, announces that the Pennsylvania Railroad will construct a plant for permanent installation at Altoona, and that this will be temporarily erected at the exposition as a part of the exhibit of that road. The entire exhibit will be under the charge of Mr. F. D. Casanave, formerly general superintendent of motive power of that road. Nothing of this kind has ever been attempted in connection with an exposition, and the valuable results already obtained upon locomotive testing plants in this country may be considered a promise of most important accomplishments at St. Louis. If a completely equipped testing plant is kept busy for seven months at the exposition and the work is carefully planned and executed, as it is sure to be, the undertaking will undoubtedly be a step toward a thorough scientific study of the modern locomotive, than which there can be no more fruitful investigation in connection with the subject of transportation.

A NEW LIGHT ON ELECTRIC LOCOMOTIVES.

If a locomotive could be always counted upon to go out upon its run, and after a run be ready to turn about immediately for the next one, it would be worth 2, or perhaps 4, or even 10 cents per mile more than one which will not do this. The electric locomotive has in this respect a stronger claim to-day for the attention of railroad men than those of economy or efficiency. The time seems to be approaching when the units of power will become so large that they must be concentrated into stationary power stations. In a transcontinental trip one now finds several opportunities for electric helper service which would now be profitable and will soon be necessary.

PILES OF WORK.

"Pile work up in front of a man and move the finished pieces promptly on to the next one when finished. Show men that the work is wanted. Get the material moving, and soon the whole shop will take a lively gait," says the progressive superintendent of a big railroad shop. What inducement does a lathe hand have for pushing his machine if the floor behind him is littered with the finished work of two or three days? Keep the floor clean of finished work, and pile up the raw material. This means a clean shop, and a clean shop means an effective and economical one. It means that the foreman will soon be wanted for larger shops, or at least for larger positions. Many shops which are now too small would be very much larger if this simple plan is carried out. It is a fact that a newspaper man always finds more to write about in a tidy shop than in a dirty, cluttered one, and it is easy to discover foremen who are fit to be master mechanics, and shop men who are capable of becoming foremen.

IMPROVED TOOLS REQUIRE IMPROVED WORKMEN.

In facing driving boxes on the Newton horizontal milling machine at the Collinwood shops of the Lake Shore is an interesting example illustrating the need for superior workmen to handle modern machine tools. This machine takes 12 driving boxes on its bed, the castings being hooked together, making a horizontal cut of about 24 ins. in width. With a 3-16-in. cut and ordinary tool-steel cutters the table speed is 7 ins. per minute on cast-iron boxes. This requires about 3 minutes per box, or, as they are arranged on the table, 20 minutes for the lot. It then requires an hour for a good man to set up the machine for another lot. If done on a planer, the job would require about four hours. This machine now has a 15-h.p. motor, and the circuit-breaker is "knocked out" under this work. A 20-h.p. motor will be applied. The motor, however, has nothing to do with the large proportion of time required to set the work in the machine. This operation is now a question of the machine being ahead of the man.

The omission of pits in locomotive erecting shops is now seriously considered in several new shop plans involving the longitudinal arrangement of tracks. This is due to a desire to avoid cutting up the floor with deep pits running the full length of the shop. With one long pit the full length of the shop in the center, the outer pits may be shortened to a short distance from one end, but it does not seem advisable to attempt to do without pits altogether. Deep pits are not necessary. Probably 18 or 24 ins. will be sufficient, but if the engines are placed on the floor it will be necessary to raise them on blocking for the men to work under them. This involves raising the men also on staging or blocking for a large amount of their work. The inconvenience and expense of this will be at once apparent.

Considering the fact that the probable life of a locomotive is about twenty years, it is most important that the policy of the designer should be a far-sighted one. Many roads find it a serious handicap to operate light, inadequate locomotives built, perhaps, seven or eight years ago, mixed up with

heavier types of more recent date. There is a tendency to give the weak engines more work than they can properly do. The mechanical engineer of a Western road comments upon this in connection with tonnage rating tests upon which he has recently been engaged and says: "We find that our 19 x 24-in. 10-wheel engines with 1,700 sq. ft. of heating surface and 30 sq. ft. of grate area are very limited in their capacity to get freight up a long, heavy grade. They are not lacking in cylinder power, but in the ability to make steam. The incapacity of the boiler is further indicated by the fact that the gases escape from the smokebox at a temperature of 1,200 deg. F. and over, while our recent heavy engines discharge their smokebox gases at only about 600 deg." This illustrates very clearly the importance of present tendencies toward most careful study of boiler capacity in deciding upon new designs. This correspondent speaks of conditions which are found on every railroad.

One of the large life insurance companies of New York recently inaugurated a school of insurance, to aid in recruiting the staff of subordinate officers and agents. One requirement of applicants was that they should be young men who had worked their way through college. Whatever the object of this, the result would naturally be to secure applicants who, from experience, knew and understood the meaning of difficulties. Most college men have an easy time. Those who work their way certainly do not, and they generally succeed afterward. The reason why they succeed is perfectly plain. They have the advantage of personal responsibility which such a course brings to them and they get it early in life.

A technical school graduate is usually past the age of 24 years when he begins his actual work. If he then serves three years as an apprentice he is at a disadvantage because of his age. The age of 27 is rather late to begin. Would it not be better for all technical men to begin in the shop in such a way as to throw responsibility upon them at the very start instead of giving them the apprenticeship? Granting that an apprentice course would give a better general idea of the department as a whole than could be obtained in the same length of time in the shop as an independent workman, yet there is something in the experience of the workman in the form of responsibility that the special apprentice does not usually acquire and cannot easily obtain at the age of 27 years. As a general principle would it not be better for all concerned, and particularly for the young graduate, to turn him loose in the shop to make his own way? In other words, is not the three or four years of special apprenticeship a handicap?

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

Machine-tool builders, of course, always make their machines strong enough to carry the heaviest possible cuts without any breakage or chattering; but a 96-in. boring mill of a familiar make did break down a few days before the visit of our representative to a certain large new shop. A 10-h.p. motor drove it, and with a 3-16-in. cut and 1/8-in. feed, boring a Latrobe tire, six teeth were broken out of the gears. The cutting speed was 28 ft. per minute. This cut was being made with a tool which had previously bored through five 56-in. tires at 28 ft. per minute, without being sharpened. That is pretty good tool steel.

This machine is, by the way, a good subject for a three-page editorial. Its motor control gives six motor speeds, and being an up-to-date machine, the gears and back gears give eight more changes, or 48 speeds in all. This is commendable, if the machine needs them, but here is something bordering on the absurd. By using a "feet per minute" indicator it was discovered that the total range of speed of the edge of that 96-in. table was from 16 to 975 ft. per minute. At the highest of these speeds chips which had dropped into the slots were thrown 25 ft. from the machine. It is unsafe to run these machines at such speeds. No work could ever require them, and the builders and those who work up motor drives should

look into these things, and not allow inquisitive newspaper men to discover them. We shall probably receive a few dozen letters because of this paragraph, but let the reader decide whether 10 miles an hour is not pretty fast for a boring-mill table to travel. This machine is *fast* enough for one intended to pull heavy cuts, but it is not *strong* enough. It is "up to" the builders.

This interesting machine is in the hands of an intelligent man who takes pride in the fact that he "sets" a 54-in. tire, bores it, and gets it out of the machine in 31 minutes. With Latrobe tires he takes a cut of 1/8 in. and 1/4-in. feed at 31 ft. per minute, but finds only one brand of tool steel which will do this work.

On some of the Western roads where travel is heavy it has been found necessary to equip passenger cars with tandem draft gear because of the excessive opening of the gear by the heavy pulls required in starting. In the case of a 16-car train the ordinary single gear is not sufficient to provide for the draw-bar stresses.

This suggests again the advisability of lightening passenger equipment. It seems rather strange that with an average the year around of 10 passengers per sleeper, or less, a weight of 125,000 or 130,000 lbs. in the cars should not lead to a protest from operating officials because of the expense which these heavy cars entail. At present it seems almost hopeless to suggest steel frames and lighter construction and steel trucks for passenger equipment, but the present tendency toward greater weights cannot continue indefinitely. It is believed that fame and fortune await the man who can produce satisfactory and smooth-riding cars with a reasonable amount of weight per passenger. These remarks are prompted by expressions of helplessness from several motive power officers because of the increase of "engine failures" and the zest with which the locomotive departments are pursued by the operating men. Locomotives, of course, should not fail; but a little study of the increased demands on passenger locomotives during the past five years will show that they have received too little consideration in the progress toward the complete comfort and convenience of the traveling public. The comfort should not be less, but intelligent and experienced officers should attack the problem of how to supply it without making it impossible to operate train service regularly and satisfactorily.

The track tank has been used for many years in connection with passenger locomotives. It is now beginning to be appreciated as a factor in freight service. This is particularly noticeable on the Michigan Central in connection with fast freight trains, such as cattle, dressed meat and special horse trains. Time freights and other classes of freight trains running among passenger trains complicate the dispatching, especially if frequent stops are made. By utilizing the track tanks the fast freights on the Michigan Central are now run without a stop from Niles to Jackson, a distance of 103 miles, and the practice has been found very satisfactory. The freight engines on this section are two-cylinder Schenectady compounds, and the service referred to has been operating smoothly for over a year. The speeds are remarkably high for freight trains, but there seems to have been no trouble whatever from hot boxes. The driving and truck boxes are given special attention at the roundhouses. They are very carefully watched and frequently replenished with oil. The enginemen co-operate with the roundhouse force in reporting the necessity for attention. The special horse trains usually weigh about 700 to 750 tons, and they cover the 103 miles in about three hours. The other fast freights weigh from 1,000 to 1,500 tons, and make the run in four to five hours. Such runs cannot always be made without stopping, but whenever an intermediate stop is necessary, the engine and train crews are required to explain it, and every effort is made to avoid the necessity of an explanation. This method greatly facilitates business, and it draws attention to the track tank as an important element in successful operation. These are days when every possible contribution to the acceleration of traffic movement is eagerly sought.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

SEMI-ANNUAL MEETING, SARATOGA, JUNE 23 TO 26.

The time of holding the semi-annual meeting this year precludes the presentation of an account of the discussions in this issue. They will be referred to next month. Brief statements concerning those of the papers most likely to interest our readers are presented below:

"The Steam Turbine from an Operating Standpoint." By F. A. Waldron.—This paper contains a description and record of tests of the first Westinghouse-Parsons turbine to be put into practical operation outside of the works of the builders. It is a most gratifying record of satisfactory experience. This is believed to be the most important paper of the meeting because of the prominent place now taken by the steam turbine and the value of the opinions expressed. Extracts from the paper will appear in these columns. The author brought out the noteworthy fact that with an evaporation of 8.7 lbs. of water per pound of coal a brake horse-power can be delivered to the pulley of a motor for the consumption of 2.5 lbs. of coal. This allows 5 per cent. for banking. With average non-condensing engines three times this amount of coal would be necessary if the engines were distributed about the plant. Special attention is directed to the interesting table of motor tests accompanying this paper.

"Alternating Current Motors for Variable Speed." By W. I. Slichter.—Variable speeds may be obtained with alternating current motors. The author reviews the existing information on this subject and discusses the various methods of obtaining speed control. This paper ought to lead those having alternating current installations to consider the advisability of securing variable speeds for machinery which requires it, and its effect is to add an argument in favor of alternating installations, or, to express it in another way, this discussion shows that the lines between alternating and direct current propositions cannot be as sharply drawn as heretofore. This paper will be presented in our columns.

"Train Resistance, a Rational Formula." By J. B. Blood.—The author expresses the need of a formula which will permit of fitting motive power to its work "with a nicety." He recommends the following formula:

$$R = A + BM \times \left(C + \frac{D}{T} \right) M^n$$

Where R = resistance in lbs. per ton, M = speed in miles per hour, T = weight of train in tons, n = exponent = 1.8, A = coefficient of sliding friction, B = coefficient of rolling friction, C = coefficient of side resistance, D = coefficient of head and stern resistances.

The values of these coefficients are given in the paper as follows: A = 3 for heavy freight trains, 4 for average passenger trains, 5 for heavy large electric cars, 6 for medium electric cars, 7 for light electric cars; B = 0.15 for light track construction, 0.12 for heavy track construction; C = 0.0016 for ordinarily constructed cars, and 0.0014 for cars with vestibules; D = 0.25 for cars with small cross section, 0.30 for electric cars with medium cross section, 0.35 for large suburban cars, and 0.40 for largest express trains. The author does not define the adjectives used in connection with these coefficients. [The real difficulty in devising satisfactory train resistance formula is that it must be comprehensive enough to provide for a vast number of entirely unknown conditions.—EDITOR.]

"Some Data on Hoisting Hooks." By J. L. Bacon.—Hooks bent from round stock were compared, by the author, with others made in accordance with Townes' formula. The paper records the results and also shows the effect of case hardening or carbonizing upon the strength of the hooks. The author concludes that hooks made of round iron and carbonized are about as strong as the hooks of the same shape flattened according to Townes' formula, while a plain hook carbonized and hardened is from 40 to 50 per cent. stronger than either.

"The Bursting of Emery Wheels." By C. H. Benjamin.—Several years ago the author was consulted in litigation occa-

sioned by the bursting of an emery wheel and determined to extend his experimental study of the bursting of fly wheels to cover emery wheels also, using apparatus which is already on record before the society. Fifteen commercial emery wheels of various makes were tested to destruction. They were selected from stock without the knowledge of the manufacturers as to the purpose for which they were required. Six different makes were obtained, the working speeds varying from 1,150 to 1,400 revolutions. For a diameter of 16 ins., this gives a peripheral velocity of about 5,000 ft. per minute. The fineness of emery, the working speeds, bursting speeds and factors of safety are stated in tabular form. The lowest factor of safety was 5.71 and the highest 13.10, the conclusion being that as the bursting speeds varied from $2\frac{1}{4}$ to $3\frac{1}{2}$ times the working speeds, the wheels were all safe at the speeds recommended and would not have burst under ordinary conditions. The author, however, recommended a factor of safety not less than 10.

"Fits and Fitting." By S. H. Moore.—This is an investigation of recent practice in forcing, shrinking, driving and running fits and limits for limit gauges. It is a study of previously existing information reduced to usable form. The available matter in the form of scientific investigation and records of successful practice was the basis of the paper. The data were transferred to rectangular co-ordinates and put into the shape of curves. Representative curves indicating good practice were then constructed and these are given in the paper in connection with formulæ. We shall refer to this paper again.

"Drawing Office Equipment." By J. McGeorge.—While concerned chiefly with a large drawing office, such as that of the Wellman-Seaver-Morgan Company, of Cleveland, with which the author is connected, this paper presents a high ideal of drawing office equipment, which is equally important in smaller establishments. The paper boils down the generalities and brings out particularly "the necessity of saving the manual and mental drudgery of the draughtsman and thereby getting the highest possible efficiency." The author reflects severely upon the policy of using poor equipment in drawing offices where such important and expensive work is done. A case is cited where a saving of \$360 per year is made by use of the cheapest material. The salary account of that office was \$100,000 per year, and probably \$10,000 to \$15,000 was lost through the saving of the small amount mentioned. The first point for consideration was *light*. Good daylight was essential, and for artificial lighting the Nernst lamp was strongly recommended. The light should be thrown to the ceiling and diffused from white walls and ceilings. Next came ventilation, a matter which was becoming more generally appreciated. An exhaust fan system was recommended. Good tables were absolutely necessary. The author's company were about to use a new and excellent table shown by means of an engraving. Good business policy required 100 sq. ft. per man for floor space. The paper concluded with a very strong argument in favor of the use of the Universal Drafting Machine. (See AMERICAN ENGINEER, December, 1902, page 389.) The paper includes plans of several large and well appointed drawing rooms.

"A Graphical Daily Balance in Manufacture." By H. L. Gantt.—This paper shows the entire feasibility of knowing exactly all the work that has been done in a large plant one day, before noon of the next day, and of securing a perfect balance of work in order to lay out that afternoon in a logical manner the work for the next day. Such information is stated to be "far more important than an improved tool steel or a new set of piece-work prices. It should be established before the introduction of either of these in order that we may have some means of measuring the gain made by their introduction, and it should remain after they are introduced, to show that a forward step once taken is never retraced. The author stands for exact knowledge of what is being done as the basis for improvement, and the paper indicates the simple details of a comprehensive and inexpensive method of securing this information as employed at the Schenectady works of the American Locomotive Company. He would make the accounting system a potent factor in helping production instead of

being critical only. This is an important paper, and every shop officer and manager or superintendent should embody something of the sort in his practice.

"Mechanics of Air Brake Systems." By H. G. Manning.—Credit for originating and bringing up to its present high efficiency the present day compressed air-brake systems all over the world is given by the author to George Westinghouse, and to him alone. The paper presents some of the principal parts of the Westinghouse, the New York and the Pennsylvania air-brake systems. It will present to the mind of the reader some of the differences in engineer's valves, pumps and triple valves made by these manufacturers.

"Test of an Hydraulic Elevator System." By R. P. Bolton.—This paper describes tests made on a passenger elevator in a department store in New York, in order to ascertain whether the contractor's guarantee was met. The elevators had a carrying capacity of 3,000 lbs. and a speed of 300 ft. per minute at that load. Each car was given a load of 1,000 lbs. From the results the following figures are taken:

Per car mile, fuel.....	32.32	lbs.
Per car mile, steam.....	231.5	"
Per car mile, water pumped.....	6,025	gals.
Live load actually lifted, per car mile.....	2,640,000	foot-lbs.
Live load actually traveled, per car mile.....	5,280,000	"
Live load lifted per pound of fuel.....	813,700	"

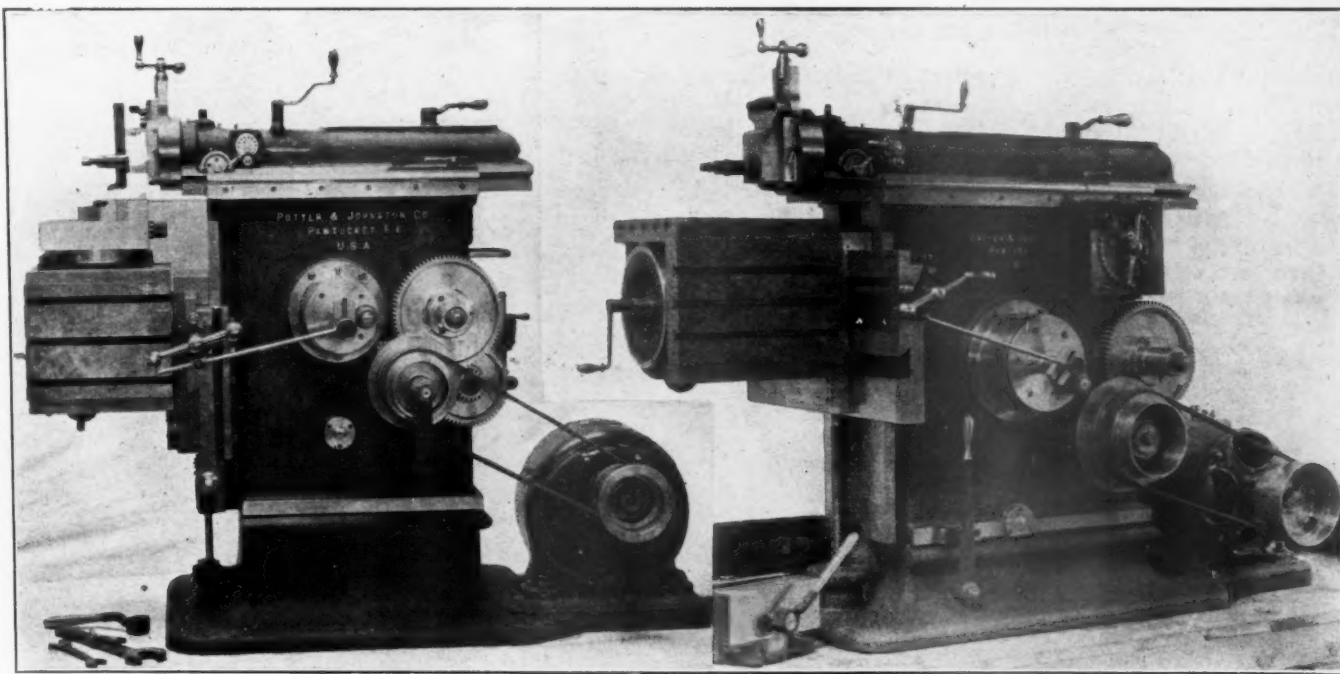
MOTOR-DRIVEN MACHINE TOOLS.

THE LATEST PRACTICE IN APPLYING INDIVIDUAL DRIVES TO SHAPERS.

No greater influence has ever been brought to bear upon the development of shapers than that resulting from the introduction of the new "high duty" steels for cutting tools, together with the modern variable-speed systems of driving whereby the operators are enabled to very quickly change cutting speeds and so secure the fullest possibilities from the great

by starting boxes conveniently located on the rear of the machine frames. It is usually feared, in drives of this type, that trouble might be given by the short belts occasioned by the closeness of the pulley centers, but the experience of the Potter & Johnston Company has proven this to be not so. The belts are run fairly tight and give no trouble.

The upper engraving on page 270 illustrates an application of motor driving to the 21-in. back-geared shaper built by the American Tool Works Company, Cincinnati, Ohio. The motor is mounted on a substantial base directly back of the column to which it is bolted. The bolt holes in the base are prolonged



BELTED DRIVES UPON 15-IN. AND 24-IN. UNIVERSAL CRANK-SHAPERS—BUILT BY THE POTTER & JOHNSTON MACHINE COMPANY.
CONSTANT-SPEED MOTORS.—GENERAL ELECTRIC COMPANY.

endurance of the tool steels. The importance of motor driving in this connection is rapidly gaining ground with users of machine tools, and in many establishments important reductions in the per-pound labor costs have been made. Several instances of such motor-drive applications to shapers by the more progressive tool builders are presented below.

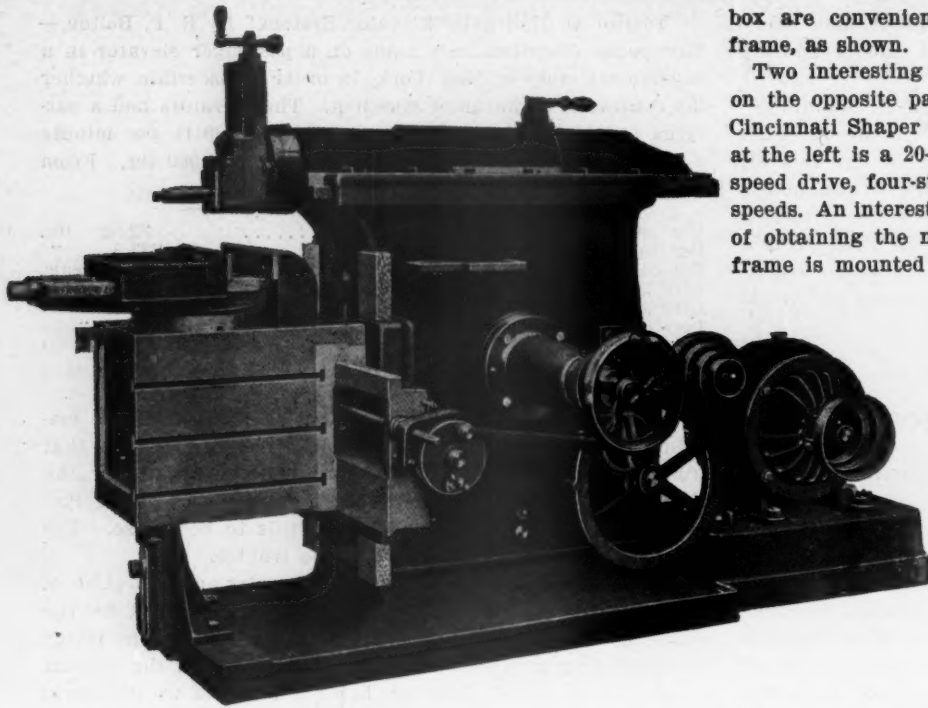
Notable among recent applications of motor driving to shapers are the two machines illustrated in the engraving presented above, which illustrate two universal shapers, built by the Potter & Johnston Machine Company, Pawtucket, R. I., thus equipped. The methods of mounting the motors in these instances are ideally simple, the motors being carried by mere extensions of the shapers' bases, to which they are rigidly bolted. The drive is by belt and cone pulleys, having three steps in each case for limited variations of speed.

The motors are General Electric Company constant-speed direct-current motors on both machines. They are controlled

into slots to permit of adjustment of the motor for tightening the belt for the drive.

The motor is of the constant-speed type, running at a high speed, the variation in cutting speed of the ram being obtained through a pair of properly proportioned cone pulleys, one of which is mounted directly on the motor shaft and the other on a stud on the column. The cone on the stud carries a pinion which meshes into a large gear on the end of the driving shaft. This arrangement is advantageous for belt driving, as it necessarily gives the belt a high velocity.

The advantages of this method of drive are obvious. The constant-speed motor gives maximum efficiency at minimum cost, speed changes being obtained mechanically; no power is dissipated through resistances, nor is a motor of extra size required, as would be the case where a variable-speed motor is installed. The belt runs at the highest permissible velocity, which permits of reduction in size of all parts connected with

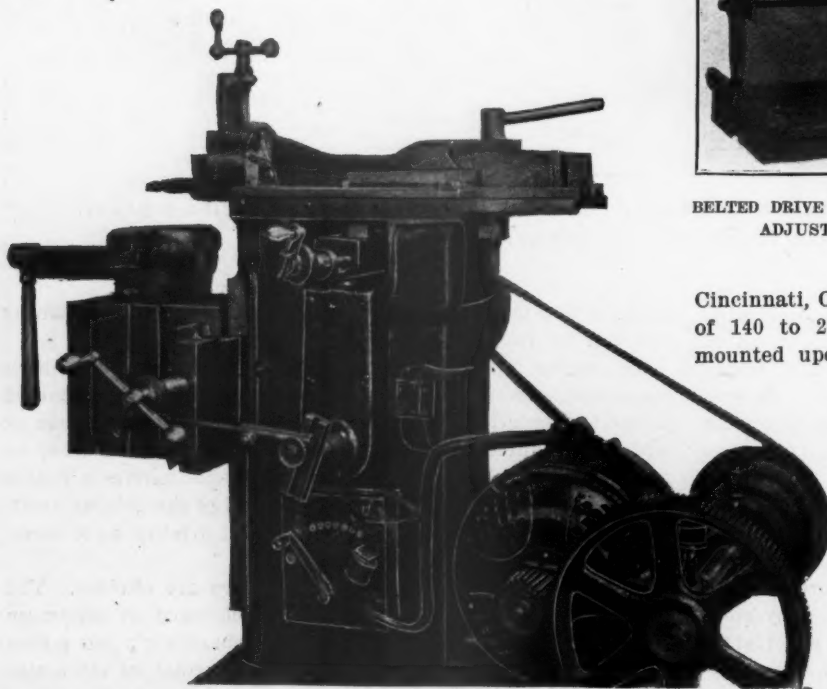


HIGH-SPEED BELTED DRIVE UPON A 21-IN. BACK-GEARED CRANK-SHAPER.—THE AMERICAN TOOL WORKS COMPANY.

the drive, making the whole an exceptionally compact arrangement and leaving space around the shaper free for the operator.

Directly below is illustrated an interesting motor-drive upon a 14-in. shaper which is in use at the works of the Triumph Electric Company, Cincinnati, Ohio. In this case also the motor is located at the rear of the shaper, being mounted upon an extension of the base. The drive is through a belt and cone pulleys having four steps for a limited number of speed changes, the motor operating at constant-speed at its best advantage. In this case also no trouble is experienced with the short belt.

The motor is 1½-h.p. constant-speed direct-current motor of the back-geared type, built by the Triumph Electric Company. It operates at a speed of 1,000 revolutions per minute, the gear reduction being one-quarter so as to drive the back shaft at 250 revolutions per minute. The main switch and starting



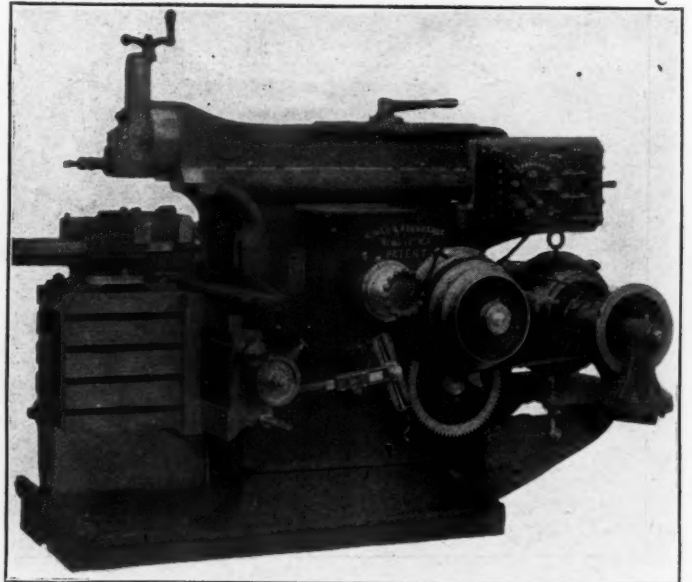
BELTED DRIVE UPON A 14-IN. CRANK-SHAPER AT THE WORKS OF THE TRIUMPH ELECTRIC COMPANY.—1½-H.P. BACK-GEARED TRIUMPH MOTOR.

box are conveniently located at the side of the machine's frame, as shown.

Two interesting motor-driven shapers are illustrated above on the opposite page. These shapers were both built by the Cincinnati Shaper Company, Cincinnati, Ohio. The one shown at the left is a 20-in. back-geared shaper and has a constant-speed drive, four-step cones being used for a limited range of speeds. An interesting feature of this application is the method of obtaining the necessary speed reduction; the cone on the frame is mounted upon a bracket and has a rawhide pinion upon its shaft which meshes with the large gear upon the drive, as shown below. This is particularly advantageous, as it permits relatively high belt velocities upon the cones.

The motor used here is a constant-speed direct-current motor built by the Jantz & Leist Electric Company, Cincinnati, Ohio. It is wound for 500 volts and operates at 1,200 revolutions per minute. The motor is mounted upon an extension of the shaper's base by guide strips which have slotted holes to permit of readily adjusting the belt tension.

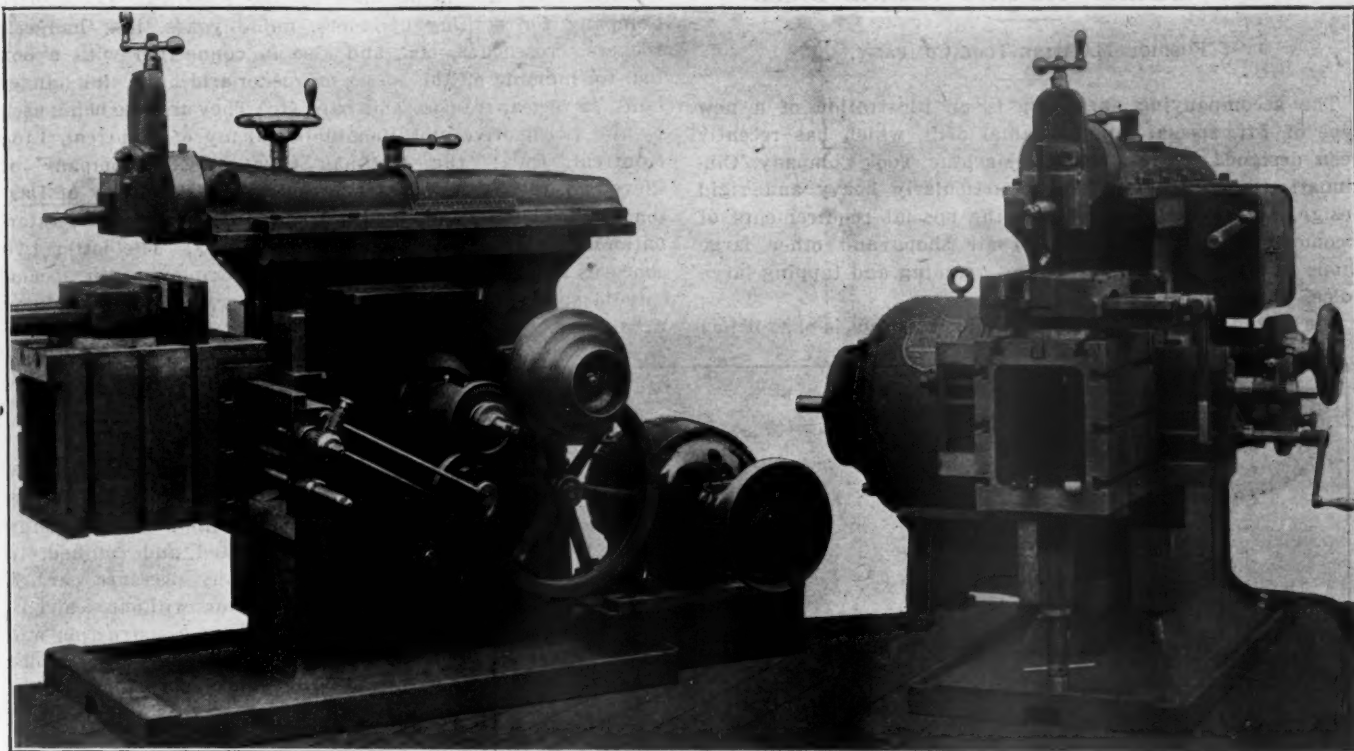
The shaper shown at the right in the above-mentioned engraving is a 16-in. back-geared shaper built by the Cincinnati Shaper Company. This machine has a variable-speed drive, the motor operating upon the multiple-voltage system. The motor, which is a type N motor, made by the Bullock Electric Manufacturing Company,



BELTED DRIVE UPON A 24-IN. QUICK-STROKE CRANK-SHAPER, WITH ADJUSTABLE MOTOR SUPPORT.—GOULD & EBERHARDT.

Cincinnati, Ohio, has a capacity of 1½ h. p. and a speed range of 140 to 280 revolutions per minute. It is in this case mounted upon a bracket at the left of the frame so as to permit of direct connection of the armature to the machine's drive. The controller for the variable speeds is conveniently located at the right of the ram, as shown in the illustration.

In this connection we desire to call attention to the excellent application of individual driving to a 26-in. rack shaper built by the Cincinnati Shaper Company, which was described on page 103 of our March, 1903, issue. This installation has been in use at the Collinwood Shops of the Lake Shore & Michigan Southern Railway for about one year with gratifying success, particularly with reference to the fly-wheel drive.



HIGH-SPEED BELTED DRIVE UPON A 20-IN CRANK SHAPER.—JANTZ & LEIST MOTOR.

MULTIPLE-VOLTAGE VARIABLE-SPEED DRIVE.—BULLOCK ELECTRIC MANUFACTURING COMPANY.

MOTOR-DRIVEN SHAPERS.—CINCINNATI SHAPER COMPANY.

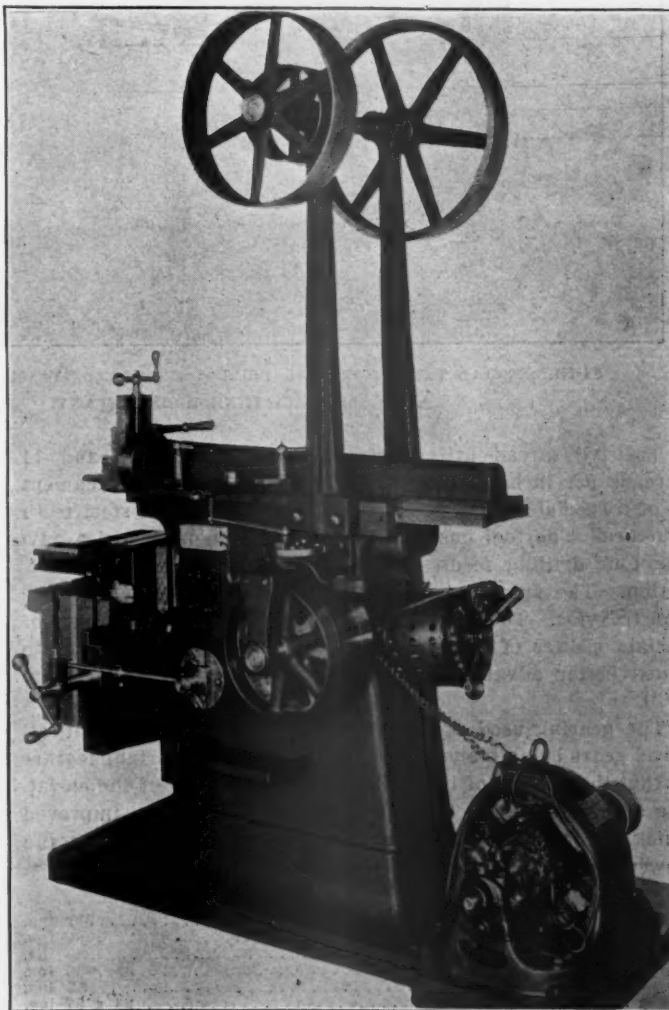
Gould & Eberhardt, of Newark, N. J., have taken a prominent stand in advocating the application of individual motor driving to shapers, and make the claim that it has decided advantages over the method of group driving from line shafting. On the opposite page is illustrated the new 24-in. quick-stroke Gould & Eberhardt shaper arranged for motor driving. The motor mounting in this case is very interesting—it consists of an extension bracket bolted to the machine's frame, to which is pivoted a rocking base for the motor. This base is provided with an adjusting screw, as shown, to permit of tilting the base to tighten the belt.

Four-step cones are used for obtaining different speeds, making eight changes with the back gear, and the Eberhardt stroke and cone scale is applied, so that the workman is always informed as to the proper step on the cone for a desired ram stroke. The belt cones are carried on stationary sleeves, the sleeves taking the belt strains, thus relieving the pinion shaft of all save the actual gear driving load. The control switch and the starting box for the motor are conveniently located upon a tablet at the rear of the frame.

The illustration at the right presents a very interesting type of motor drive for a shaper. The shaper illustrated is a 24-in. triple-gear rack shaper built by the John Steptoe Shaper Company, Cincinnati, Ohio. The drive is from a constant-speed motor, used in connection with a countershaft carried by upright brackets upon the tool. The motor is bolted on an extension of the base and is belted from the motor to the large pulley on the countershaft. This pulley is purposely made heavier than ordinary, and, as stated by the makers: "Is intended to act as a fly-wheel, holding the full load on the motor longer than would otherwise be the case and thus doing away with sudden variations of the load." (In this connection permit us to call attention to the editorial entitled: "Fly-wheels on Planer Drives," on page 227 of our June issue.)

The builders state that this method of driving by a motor gives a smooth, easy motion to the ram and can be fully controlled from the usual position of the operator, as, although the starting box is at the rear of the column, the motor may be stopped, if necessary to stop the machine for some time, by throwing out the switch on the side of the column; while for purposes of examining, and placing or removing work, the ram may be stopped instantly at any point desired by the belt shifting lever. The motor used in this instance is a 500-volt

direct-current constant-speed Westinghouse motor of 2-h.p. capacity and operates at 1,200 revolutions per minute.



NOVEL BELTED DRIVE WITH FLY-WHEEL UPON A 24-IN. RACK SHAPER. JOHN STEPTOE SHAPER COMPANY.

2-H.P. CONSTANT-SPEED MOTOR.—WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.

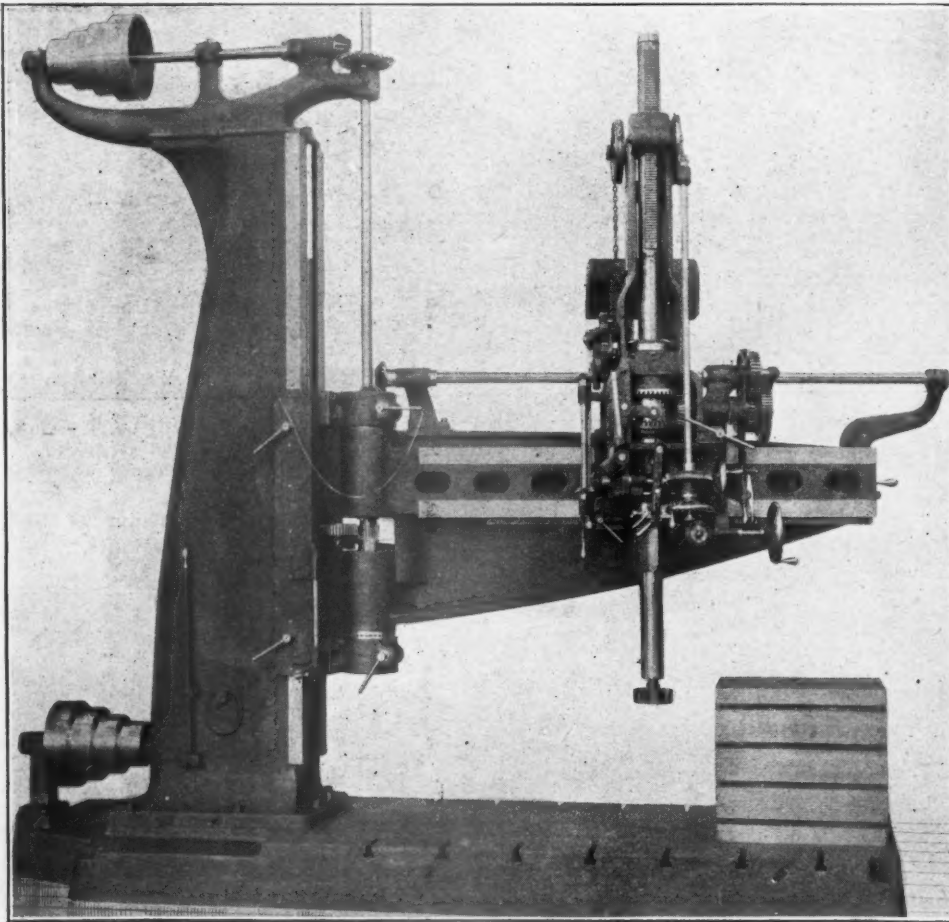
A NEW SPECIAL TAPPING RADIAL DRILL.

FOSDICK MACHINE TOOL COMPANY.

The accompanying engraving is an illustration of a new type of 7-ft. special tapping radial drill, which has recently been designed by the Fosdick Machine Tool Company, Cincinnati, Ohio. It embodies a particularly heavy and rigid design, being intended to meet the special requirements of locomotive builders, railroad repair shops and other large shops in boring cylinders, drilling, reaming and tapping large holes, etc.

One of the distinctly new features of this tool is that it has

These tools are being used by the American Locomotive Company for drilling cylinders, guide yokes, link hangers, rockers, crossheads, etc., and also in connection with a box tool for hubbing off the bosses on rocker-arm hubs, link-hanger hubs, valve-gear transmission bars, etc. They are also being used by the Locomotive and Machine Company of Montreal, Ltd., Montreal, Que.; the Wellman-Seaver-Morgan Company of Cleveland, the Stilwell-Bierce & Smith-Vaile Company of Dayton, Ohio, and the Laidlaw-Dunn-Gordon branch of the International Steam Pump Company, Cincinnati. The latter two concerns are using them on pump work, employing the special spindle speeds to excellent advantage for screwing in pump-valve seats.



84-IN. SPECIAL TAPPING RADIAL DRILL FOR LOCOMOTIVE MACHINE WORK.—
FOSDICK MACHINE TOOL COMPANY.

a positive thread-cutting attachment for 8, 10, 12 and 14 threads per inch for heavy tapping. The tapping attachment is of a special design, constructed of hardened tool steel teeth clutches. The tool has also a variable-speed feed device, giving four drilling feeds, varying from .014 to .0079 per revolution. The spindle is 3-15-16 ins. in diameter, and has 30 ins. traverse. These features make it possible to take care of certain classes of large work, heavy drilling, tapping, etc., to much better advantage than is possible on the plain radial drill.

The gearing used upon this drill is of steel throughout, all bevel gears being planed from the solid. An important feature is that the thrusts of the arm, of the spindle and of the elevating screw are taken by ball thrust bearings. The improved quick return used upon the head permits of engaging the power feed instantly.

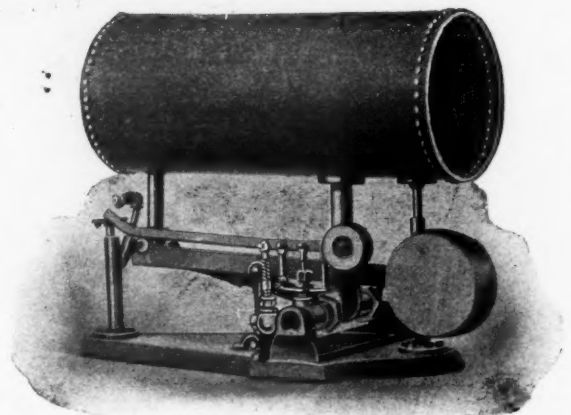
SPECIFICATIONS.

Drills to center of circles of diameter.....	172 ins.
Greatest distance from spindle to base.....	90 ins.
Traverse of spindle.....	30 ins.
Traverse of saddle.....	65 ins.
Traverse of head on arm.....	57 ins.
Table.....	24 x 27 ins.
Height of drill.....	13 ft.
Total height with arm raised.....	18 ft. 6 ins.
Floor space.....	14 ft. 1 in. x 17 ft. 4 ins.
Weight, net.....	20,000 lbs.

THE MOREHEAD RETURN TRAP.

The Morehead return trap is constructed of steel, the heads and longitudinal seams being closely riveted and caulked, to withstand any pressure carried on the boiler without leakage. It is simple in construction and has no rubber joints to blow out or leak, and only one valve, which is on the outside. All working parts are on the outside, in plain sight, and easily accessible.

This trap is located 6 ft. or more above the water-line of the boiler. The water from the condensing surfaces is forced by the pressure of the steam behind, through a pipe leading to the trap, with a swing check valve close to the latter. As soon as sufficient water has entered the receiver to overcome the counter-balance weight the receiver tilts down, allowing the water to pass through the discharge pipe, at the same time open the steam valve, which has a pipe connected with the dome of the boiler. By thus equalizing the pressure on the surface



THE MOREHEAD RETURN STEAM TRAP.—AMERICAN
BLOWER COMPANY.

of the water in the receiver with that in the boiler the water flows by gravity into the boiler. As soon as the receiver is empty it tilts back as before and again refills. The trap is prompt in opening and closing, its action being entirely due to gravity. When once set up it requires no further attention. It takes the water from the condensing surfaces,

whether they are above or below the water level in the boiler, and automatically returns it to the boiler at the temperature due to the pressure at which the steam is condensed. There is no outlet by which the steam can be wasted. The trap is said to be quick and positive in delivering the water into the boiler against any pressure, and regardless of fluctuations of pressure. It supplies all the water needed in the boiler from duties of a pump or injector. It is reported to operate equally the main water pipe (providing there is enough pressure on the main to lift the water to the trap) thus performing the well with high or low pressure coils, or coils using exhaust steam, allowing no condensation to collect in them. For a boiler plant of 200 h.p. having an efficiency of 65 per cent. and an evaporation of 6,900 lbs. of water per hour, from and at 212 degs., under average conditions, the saving effected by a Morehead return trap for a year is more than twice the cost of installing one large enough to handle such a plant.

Where a return trap of this kind is not employed, the usual way of handling condensation is by means of a pump. A comparison of the two methods shows many points of advantage in favor of the former. A pump will not lift water at temperatures exceeding 212 degs.; a Morehead return trap will do so. A pump consumes an extravagant amount of steam to do a very little work. For example, an ordinary duplex boiler-feed pump requires from 90 to 120 lbs. of steam per horse-power hour and a common slide-valve engine seldom consumes less than 40 lbs. per horse-power. The pressure is admitted to the surface of the water, and is automatically shut off before the tank is empty. The steam used is only such as is condensed by the heat passing from it into the water in the tank, which is all put back into the boiler.

It is claimed that a Morehead return trap requires practically no attention; needs no lubrication; will not race or run away; is noiseless; requires little room and no foundation. Full information may be obtained by addressing the American Blower Company, of Detroit, Mich.

The Kennicott Water Softener Company announce that they have secured the services of Professor W. M. Bruce, formerly of the University of Chicago, who has assumed full charge of their laboratories.

The Gold Car Heating and Lighting Company has brought suit in the United States Circuit Court, Northern District of Illinois, at Chicago, Ill., against Egbert H. Gold, for infringement of United States letters patent No. 388,772 for car-heating apparatus.

We are requested to direct the attention of railroad managers to the special service division of the Edward Smith Company which is stated to have been very successful in connection with reorganizations of various departments of railroads in reducing expenses and raising the operation of departments to the highest possible standards. The Edward Smith Company employs mechanical experts who enter the service of the railroad as regular employees. They investigate conditions and furnish detailed reports with recommendations as to possible methods for improvement. Information and references will be furnished on application to Edward Smith, vice-president and general manager of the Edward Smith Company, Detroit, Michigan.

Mention has been made several times recently in this paper concerning the rapid strides which have been taken by the Pressed Steel Car Company of Pittsburg in the manufacture of pressed steel cars, and it is with pleasure that we note that this company has built and shipped, up to and including May 29, 1903, 100,467 cars. This figure represents the actual number of cars which are in service to-day manufactured by the Pressed Steel Car Company, which includes steel cars as well as wooden cars for which steel underframes have been furnished. This company has for some time past shipped over 120 cars per day from its McKees Rocks and Allegheny plants, using in the manufacture of these cars from 45,000 to 50,000 tons of steel plates per month. From the present outlook all previous records which have been established in car building will be eclipsed. It is estimated that the output this year will exceed 38,000 finished cars. Large orders for cars, both wooden and steel, have been received for early delivery, in addition to a large number of pressed steel body and truck bolsters, freight car and engine tender trucks, as well as other pressed steel specialties for wooden and steel cars.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

DRAWBAR AND BUFFER ATTACHMENTS FOR USE BETWEEN ENGINE AND TENDER.

INDIVIDUAL PAPER BY HENRY BARTLETT.

Editor's Note.—After commenting upon the uncertainty and non-uniformity of practice in these attachments the author points to the great magnitude of the stresses involved and indicates the fundamental principles of correct construction. He discusses the frame and strength of drawbars, the lifting effect of offset bars, the effect of springs and slack in the buffers, and then presents two possible solutions. The paper is an excellent one, giving detail drawings of a large number of draft connections. It concludes with the following summary:

In want of any actual information as to the behavior, hopeful or otherwise, of an adaption of M. C. B. coupler principle between engine and tender, I am disposed therefore to propose as a final recommendation:

1. That the provision for buffing stresses take the best possible form of an adjustable wedge.
2. That the drawbars be straight, even at the expense of re-designing foot plates and tender front draw castings in new work and renewals.
3. That the drawbar pinholes be provided with ample bearing area.
4. That an elongated eye be provided at one end to prevent the bar from ever coming into compression.
5. That sufficient stock be provided at both ends, to prolong the wear in the pinholes.
6. That 4,000 lbs. be aimed at as the working stress with straight bars.
7. That the drawbar shall be of the best materials, and that a limit shall be set to the repetition of welding a bar in repairs.

Finally, that a system of inspection of drawbars and related gear at stated frequent intervals be instituted and rigorously observed.

RECENT IMPROVEMENTS IN BOILER DESIGN.

COMMITTEE—D. VAN ALSTINE, G. R. HENDERSON, T. W. DEMAREST, O. H. REYNOLDS, JOHN PLAYER.

Editor's Note.—This valuable illustrated review of present tendencies in boiler design indicates the universal desire to secure maximum capacity, the efforts of the past year having been in this direction. The wide firebox now rapidly assuming a position as a standard of construction was responsible for the great addition to the length of tubes. A table of dimensions of recent boilers shows the tendency toward larger heating surfaces both here and abroad. The use of the Drummond water tube firebox construction (see AMERICAN ENGINEER, March, 1899, page 79) was prominently mentioned in the report and attention was called to the progress of super-heating both here and in Europe. The committee laid special stress upon the fallacy of crowding boilers with tubes to the detriment of circulation. The report concludes with the following opinions with regard to boiler practice:

The committee has reached the conclusion that boiler troubles have increased in proportion to the increase in size and steam pressure of boilers.

Those roads having very little trouble with old boilers are having very little more with modern boilers, and those which have always had a good deal by comparison, are having a good deal more with their modern boilers. Poor water is evidently the chief cause of boiler troubles, though it is evident that poor coal, severity of service, contracted water spaces, etc., contribute to an aggravation of the trouble. It would appear also that in poor water the incrusting solids are not always the governing factor, but that other solids also have their effect in producing cracked side sheets and leaky flues.

One horse-power for 3 sq. ft. of heating surface seems to be about all that can be safely relied upon as a regular performance with water ordinarily found in the middle and western States, but this can be improved upon where water is of better quality.

There seems to be no question but that the wide grate is at least 10 per cent. more economical than the narrow, in burning bituminous coal, but that its economy while running is to some extent offset by its comparative waste of coal while standing idle on side tracks or at terminals, and this waste appears to increase proportionally to the increase in grate area.

No conclusion could be made as to the maximum grate area which a fireman can economically fire, but it no doubt depends on the quality of the coal, and for a clinkering coal would appear to be in the neighborhood of 45 sq. ft.

Treating water in locomotive tenders is undoubtedly beneficial, provided it is followed with frequent blowing down and washing out, in that it retards the formation of scale and overheating. The quality of the water may be so poor, however, as to require so much soda ash or other reagent and hence so much washing out that the good effects of the soda ash are offset by the bad effects of too much washing out.

The correct method of treating water appears to be in station tanks so that solid matter does not get into the boiler, but even by this treatment there seems to be danger of making the water so alkaline as to foam badly.

The committee would call attention in this connection to retarded circulation to such an extent that flues and back-flue sheet

are frequently and highly overheated. Wide fireboxes, poor coal and poor firing admit large volumes of cold air against overheated flues and sheets and the wide range of temperature to which flues are subjected loosens them circumferentially and draws them in and out longitudinally. Flues are frequently found so loose that they can be shaken in the sheet. Short pieces of flue rolled into a piece of $\frac{1}{2}$ -in. firebox steel in the usual manner, heated to a dull red and suddenly cooled require a considerable number of heatings to make them loose. This is not exactly a parallel case to flues in a boiler, but the conditions are somewhat similar.

An experiment was made to determine the temperature surrounding flues by plugging certain flues at both ends with asbestos and placing asbestos plugs 2 ft. apart throughout the length of the flue with two pieces of fusible metal in each space, one piece melting at 410° to 420° and the other from 440° to 450° Fahr. The results are given in Table No. 3 (not reproduced), and show that the temperature surrounding the flues was considerably above the temperature of saturated steam at 220 lbs. at the back end and in the case of upper flues it was higher all the way through.

If the surrounding temperature is so high in a flue thus plugged it must be still higher about flues through which fire is passing, and it is probable that the temperature at flue sheet is very much higher. There is no evidence to prove that a flue will not stand a considerable amount of overheating without leaking, but it would appear that those that are leaking are subjected to too high and too great a range of temperature.

It is only necessary to have a sufficient body of water against side sheets to reduce cracked side sheets and broken stay bolts to a minimum. It should follow that flues can be spread far enough apart to stop their leaking, but the spreading of flues reduces the heating surface very rapidly and the widest spacing the committee has knowledge of, namely, $3\frac{1}{2}$ -in. centers for 2-in. flues, has not cured the trouble.

In conclusion the committee would recommend the appointment of a committee for the ensuing year to further investigate the question of leaky flues.

PISTON VALVES.

COMMITTEE—F. F. GAINES, R. P. C. SANDERSON, F. H. CLARK.

From the replies received it would seem that the type of valves more generally favored is either the hollow internal admission or hollow external admission, and while there is a fair proportion of solid internal admission valves there are very few solid external admission valves in use, unless we consider the piston valve used on the Vaucain compound as being of this type.

The D. & H. Co. state: "In the spring of 1902, Messrs. Campbell and DuBois, seniors of Cornell University, made a comparative test in freight service in Class E-2 and E-3 engines. The engines were laden proportionately to tractive power. Deductions gathered from this test show a saving on the piston valve engine of 1.8 per cent. due to valve. The piston valves were new, and the slide valves were recently shopped." While not so stated, this economy is apparently due to steam distribution, and as the percentage of gain is so small it is questionable if, after the elimination of errors of observation, there would remain any advantage. Several other roads express preferences, but without giving reasons so fully.

As regards the ratio of diameter of cylinder to cylinder of valve both in simple and compound engines there seems to be a large variation between the maximum practice and the minimum practice. In simple engines the high pressure varies from 1.66 to 2.1. For the Vaucain compound system the high pressure varies from 1 to 1.38, and for the low-pressure cylinder from 1.67 to 2.30. The variation in the other types of compounds is not so marked, due to fewer replies being received covering these types. It is the opinion of the committee that the lower ratios indicate the better practice and that the higher ratios should only be used on freight and switching engines.

As regards the value of the various types of relief valves from water it is not thought that the valve in cylinder head fulfills its function in the manner that it is expected to. It has been the experience of one road that these valves, after being in service for a short time, corrode, or through other causes fail to lift at the pressure at which they are set, and that they are of but little value as relief from water in cylinders. As to relief when drifting, very few of the by-pass valves or relief valves are thoroughly successful where the speed is high.

Various types of packing rings are in use, as well as rings of the same style varying greatly in their dimensions. The rectangular cast-iron snap ring, together with the cast-iron "L" ring, appears to be used in the majority of cases, while for the rectangular rings about $\frac{3}{8}$ by $\frac{1}{2}$ in. and for "L" rings $\frac{5}{8}$ by $\frac{1}{2}$ in. seem to be the prevailing sizes. In some few of the valves provided with followers heavier rings are used, and it is questionable if the prevailing practice is not too light rather than too heavy. As regards the various advantages of the rectangular and "L" shaped rings, it would seem that the rectangular rings generally have the advantage of strength, longer life, cheaper cost and cheaper maintenance, while to offset this, the "L" ring, especially on high-speed engines, gives a very much better port opening with less wire drawing of steam. The "L" ring naturally has a greater unbalanced surface than the rectangular ring, and it is the experience of one road that it wears both itself and the chamber very much more rapidly than the rectangular ring. Your committee believes that in most designs the extension part of the "L" ring projects too far.

Relative to exhaust effect, the Chicago, Burlington & Quincy states as follows: "We have made experiments on valve friction of internal admission piston valves of both hollow and solid types. With the solid valve, cards taken show that at slow speed there is an excessive push forward on the valve when exhaust first opens."

The Boston & Maine states as follows: "We have made no test on piston valves for friction. We observed that when our first consolidation engines arrived, they soon began to sound badly out of square, the indicator diagram showing that the valves were

not cutting off equally, yet no discrepancies could be found in the valve setting or motion work. The defect was attributed to the removal of pressure from back end of the valve by the valve stem, the greater pressure on the front end keeping the slack all taken up in one direction and allowing valve to keep as far back as possible. This condition existed for speeds up to 30 miles per hour, above which, apparently, the inertia of the parts overcame the unbalanced force. The inequalities of the exhaust sound increased with increased slack in the motion work. The trouble was overcome by enlarging the back head of the valve by an area equal to area of the valve stem."

No experiments seem to have been made with a view to determining the steam lost due to worn rings, and judging from remarks made at the topical discussion on this subject at last year's meeting, it would seem that there is a wide variation of opinion as to the amount of this loss. One road states that while having made no accurate tests to determine the steam loss due to wear of packing rings, two of the master mechanics who had made shop tests on this point, are of the opinion that the rings can easily represent a loss of 15 per cent. over steam consumption with rings in first-class condition.

Only two roads replying to the circular acknowledge having had any experience with the new type of American balance slide valve. One of these states that two engines are equipped with most excellent results. The other has had four engines equipped for about a year's time, and, with the exception of some minor difficulties in the start which were later overcome, the results have been very good. The valve (see AMERICAN ENGINEER, April, 1902, page 125) has both double admission and double exhaust features, and while no indicator cards have ever been taken to show how much has been gained by this feature, there can be no question but that it is an appreciable factor. Your attention is also called to the fact that with this type of valve, all balancing parts are stationary and not subject to wear, and that in two different ways a very short steam port may be obtained. One of these will be found illustrated in connection with the valve mentioned in the Appendix, showing cylinders upon which it is used, and how, by making wide shallow exhaust cavity in cylinder, a short steam port was obtained. The other method by which this can be accomplished is to use inside admission, as there is nothing in the way of balancing this valve equally as well for inside as for outside admission, although it is believed the latter has not yet been tried. Notwithstanding the large size of this valve as illustrated, in connection with 210 lbs. of steam, the engine can be handled with a full throttle with ease, showing that valve is perfectly balanced. It also has the advantage of providing for relief from over pressure in the cylinders by lifting in the same manner as the ordinary slide valve, and on account of the double exhaust feature there must be considerable decrease in back pressure, which is evidenced to a certain extent by the very short, sharp exhaust.

The replies as to the chief advantages of piston valve seem to be fairly uniform and consist, in the main, of better balancing, which includes ease of handling and decrease in wear and tear of motion work. In addition, some replies give less cylinder clearance, better steam distribution, less cost for maintenance, shorter steam passes, decreased back pressure, better distribution, larger port openings; and on the four-cylinder compound the fact that the piston valve really takes the place of the two valves, in that it distributes the steam to both high and low-pressure cylinder, greatly simplifies the motion work and the number of parts. It is questionable if all the advantages claimed are real and tangible, as it seems that some of these attributes can be obtained equally as well or better with other types of valve. It would seem that the question of lubrication is not a settled one. The reply of one road states that where engines with piston valves have to drift for long distances the question of properly lubricating the piston valve becomes a very serious problem, and it is hoped that a discussion of this paper will bring out some more definite information on these points. It would seem that the reason for the growing favor in which the piston valve is held is due largely to reasons as given by one of the roads in reply to the circular, as follows: "Our reasons for taking up the piston valve are that with the increased size of engines and steam pressure the ordinary balance 'D' slide valve increases in size proportionately, and while we may balance the valve in the same ratio as the valves on the smaller engines, the difference in unbalanced surface increases with the size of the engine. This increases the wear on the valve and link motion, eccentrics and straps, and increases the work necessary on the part of the engineman to handle the engine." The foregoing reasons probably cover the situation, the Lake Shore stating that on a very careful test an economy of about 5 per cent. was shown, which they considered due to back pressure and perhaps slightly to decrease of amount of compression.

In the Appendix which accompanies this report will be found the tests referred to on various types of valves and valve bushings, which illustrate very thoroughly the practice of this country as regards the piston valve. Some of the modifications as to design of ring will be found very interesting.

From the replies to some of the questions it is very evident that little or no data is available on some of the subjects brought up in connection with the piston valve. Your committee, therefore, recommends:

First: That tests be made to determine the amount of loss of steam due to worn packing rings. Such tests should include the various types of rings illustrated in the report.

Second: That tests be made to determine whether the steam or the exhaust rings are the most responsible for the decreased efficiency due to wear.

Third: That the question of proper lubrication of piston valves when drifting be more thoroughly investigated.

Fourth: The attention of the committee being called to the question of valve setting in connection with the piston valve, after it was too late to include it in the circular, by one road stating that with identical valve motions, to obtain equal work, modifications in the piston valve setting must be made, it is suggested that further investigation be made along this line.

LOCOMOTIVE FRONT ENDS.

COMMITTEE—H. H. VAUGHAN, F. H. CLARK, A. W. GIBBS, W. F. M. GOSS, ROBERT QUAYLE.

Your Committee on Locomotive Front Ends, appointed to assist the AMERICAN ENGINEER AND RAILROAD JOURNAL in the tests being carried out at Purdue University along the lines of

- (a) Proper dimensions for standard front end,
- (b) Elimination of cinder valves,
- (c) Elimination of the diaphragm,

begs to report as follows:

Since the conclusions derived from the tests being carried out by Purdue University, under the arrangements made with the AMERICAN ENGINEER, were not immediately available when this committee was appointed, it was deemed inadvisable to hold an early meeting as instructed by the Executive Committee, and action was therefore deferred until Professor Goss presented a complete report. On receipt of this it was at once seen that a most valuable addition to existing information on the front end problem had been made and that the experiments certainly decided the relations of the stack and nozzle definitely and finally so far as it could be possible to do so on a testing plant. The conclusions are of such importance that we consider they should now be recorded in the report of this committee for the information of the members. The report presented also included a section devoted to a problem for further study. As this outlines as desirable a series of tests and is with one addition entirely concurred in by your committee this section is also included.

The sections above referred to which are reproduced from the AMERICAN ENGINEER are as follows:

Editor's Note—At this point the report presents the Summary of Results constituting Section VII. of the report by Professor Goss, which appeared in the June number of the AMERICAN ENGINEER, followed by Section VIII., Problems for Further Study. The committee report then proceeds as follows:

It might be stated that the engine on which these tests were made had a front end 54 ins. in diameter, and the conclusions adapting the results obtained on this engine to those of a larger size were obtained by considering the diameter of the front end as a unit, and increasing the size of the stack in direct proportion. While this may be a correct method, we feel, since all locomotives recently built or that are liable to be constructed in the future will have front ends of considerably larger sizes, this subject will not be left in a satisfactory condition unless further tests are carried out to confirm or correct this assumption.

We were advised by Professor Goss that it would not be possible to carry out further tests in continuation of the AMERICAN ENGINEER series prior to June, 1903, on account of the conditions at Purdue University, and we also anticipated that considerable difficulty would be experienced in obtaining the use of a sufficiently large engine with the present demand for power. It was, therefore, decided to request those members who formed the original committee organized to assist in the AMERICAN ENGINEER tests to make experiments in service to confirm the results obtained by Professor Goss. The majority were compelled to reply that, owing to the large amount of work then being carried on in their respective departments, they would be unable to assist during the present year and only three series of tests have been carried out. These have only been partially made and the results are not sufficiently complete to present in this report, although it may be stated that they practically confirm the conclusions arrived at on an engine having a front end of the same size as that used at Purdue University, but leave it open to question whether these results are immediately applicable to engines having a considerably larger front end. We are pleased to be able to announce that through the courtesy of one of the members of this association, Mr. J. F. Deems, General Superintendent of Motive Power and Rolling Stock, of the New York Central & Hudson River Railroad and Lake Shore & Michigan Southern Railway, arrangements have been made by which a large modern engine, having a front end 75 ins. in diameter, will be available to allow this series of tests to be completed. This will enable the determination of the correct unit to be used for stack diameters to be made, and a further series of tests carried out along the line recommended by Professor Goss. Your committee, therefore, asks to be continued in order that during the coming year it may carry out the purpose for which it was appointed.

EFFECTS OF TONNAGE RATINGS ON THE COST OF TRANSPORTATION.

INDIVIDUAL PAPER BY C. H. QUEREAU.

There have been indirect savings in operating expenses, due to the use of tonnage ratings, which are not always considered. I refer to the use of the ton-mile basis for statistics, which naturally followed the introduction of tonnage ratings. Previously the almost universal basis of motive power statistics had been the engine-mile. Because the engines made more miles per ton of coal the lighter the train, there was a constant effort on the part of master mechanics and engineers to haul as light trains as possible in order to improve their records, which no doubt in a measure neutralized the efforts of the transportation department to handle as heavy trains as possible, and undoubtedly increased the cost of transportation somewhat, when compared with the possibilities, and was a source of constant friction between the two departments. The ton-mile basis for motive power statistics changed all this, because it was soon demonstrated that the heavier the train, within reasonable limits, the less the cost of coal, wages and repairs per ton-mile, and, therefore, it was to the interest of the motive power men to haul as heavy trains as practicable, thus harmonizing the interests and efforts of the employees of both the transportation and motive power departments.

The ton-mile basis also corrected a number of erroneous conclusions, resulting in a clearer understanding of cause and effect,

which no doubt led to economies. A few illustrations will probably make this point plainer than an extended description. The figures given are actual records.

TABLE I.

	March, 1896.	1897.	Increase Per Cent.
Average miles per engine.....	2,282	2,289	0.3
Average ton-miles per engine.....	782,213	972,486	24

Had there been no ton-mile statistics, there can be little doubt the conclusion would have been drawn that the average work done per engine in the two years was practically the same. The ton-mile figures show this conclusion would have been wide of the mark and misleading, and also demonstrate that in this case the use of tonnage ratings increased the work done by the engines 24 per cent., as the class of locomotives was practically the same in the two years.

TABLE II.

DIVISION D.—JANUARY, 1896.

	Miles to Ton of Coal.	Coal per 100 Ton-miles.
	Lbs. Per Cent.	Lbs. Per Cent.
Main line, freight.....	16.6 100	20.79 100
Branch, freight.....	14.8 112	67.93 327
Main line, freight.....	16.6 193	20.79 100
Main line, passenger.....	32.1 100	33.09 159

Judged by the results on the engine-mile basis, the branch freight engines were using only 12 per cent. more coal than those on the main line. This record was considered very satisfactory indeed, so far as the branch was concerned, as there were a considerable number of heavy grades and curves on it, while the main line was comparatively level and straight, and the conclusion was naturally drawn that it was not much more expensive, so far as fuel was concerned, to operate a mountain district than one on the prairie. But as soon as attention was directed to the figures based on the ton-mile it became evident that the heavy grades and curves of the branch required three and a quarter times as much coal as the main line to do the same amount of work.

In comparing the relative cost of fuel in freight and passenger service, using the engine-mile as a basis, the almost inevitable conclusion was that freight engines used nearly twice as much as passenger engines, but when the basis of comparison was the ton-mile, it became evident that the cost of fuel was practically 60 per cent. greater in passenger service.

The discussion would, however, fall far short of completeness if it did not include another phase of the subject, at least suggest that there is still room for decided improvement and call attention to the fact that tonnage ratings, though a decided improvement over the car ratings, may easily be carried to extremes and result in increased, instead of decreased, transportation costs, and that there is still a wide field for scientific investigation in the matter of locomotive ratings and transportation statistics.

It is very generally assumed that the maximum tonnage a locomotive can handle at a speed of about ten miles an hour is the most economical. I venture to differ from this opinion and will first consider the matter as applying to the conditions which have prevailed throughout the past winter, during which time there has existed practically a freight blockade. Under these conditions the paramount issue, to borrow a political phrase, is to handle the business offered and keep it moving almost regardless of cost; in short, to handle the largest possible number of cars with the power and facilities available.

For the sake of argument and illustration, Table III. is presented. It applies to two divisions; the first 100 miles and the second 200 miles in length, and is based on the following assumptions: First, that it requires four hours to get an engine from its train to the roundhouse, clean its fires, give it necessary repairs, furnish the necessary supplies and have it on its train again; second, that a train of 40 cars will allow an average speed of 10 miles an hour; third, that a reduction of the train from 40 to 35.2 cars, or 12 per cent., will permit an increase in the average speed to 15 miles an hour.

TABLE III.

	100-Mile Division.		200-Mile Division.	
Speed, miles per hour.....	10	15	10	15
Hours between terminals.....	10	6.67	20	13.32
Hours at terminal.....	4	4	4	4
Hours for one trip.....	14	10.67	24	17.32
Trips in thirty days.....	51.4	67.5	30	41.6
Cars hauled per trip.....	40	35.2	40	35.2
Cars hauled per month.....	2,056	2,376	1,200	1,464
Gain in cars handled per month..		320		264
Gain in cars handled per month, per cent.		16		22

These figures show an increase of from 16 to 22 per cent. in the number of cars an engine will handle per month, due to a decrease of 12 per cent. in the number of cars handled per train, and that the longer the division the greater the increase.

The following figures give the percentages of overtime paid engineers and firemen, in relation to their total wages, during June, when there was no special rush of business and the engines available were ample to handle it easily, and during September, when the power was taxed to its utmost capacity:

	Division A.	Division B.
June—Overtime, per cent. of total wages.....	1.8	2.0
September—Overtime, per cent. of total wages.....	5.3	4.6

The above shows conclusively that the overtime paid increased from two to three times as much as the business done, as determined by the wages paid enginemen.

The reasons which make it seem more than probable that a reduction of maximum tonnage ratings would decrease the cost of wages per ton-mile apply with equal force to the cost of fuel; not that the cost of fuel while running would be much, if any, greater per ton-mile with the maximum tonnage, but that the longer delays on side-tracks, the longer hours for the train and engine crews and the damage done the fire while pulling out of

side-tracks with the heaviest trains would result in a greater cost of fuel per ton-mile.

I believe the discussion and facts given warrant the conclusion that tonnage ratings which limit the average speed of freight trains to 10 miles an hour, or less, result in a greater cost of transportation and decreased earning power for motive power than ratings which allow a somewhat higher speed. If this conclusion is accepted, it follows that such maximum tonnage ratings produce a higher cost of transportation than is necessary and that the subject is well worth extended, careful and scientific investigation.

The adoption of tonnage ratings for freight trains has reduced the cost of transportation by increasing the average trainload; by reducing the cases of doubling and overtime; by furnishing a basis of common interest for the operating and motive power departments to handle full trains, and by furnishing a fairer basis for judging operating and motive power efficiency.

It seems, however, evident that, as is usual when any new plan has proved beneficial, the pendulum has swung to the opposite extreme and the maximum tonnage ratings are, as a rule, greater than the most economical ratings. At least the evidence at hand warrants systematic and scientific investigation.

ELECTRICALLY DRIVEN SHOPS.

COMMITTEE—C. A. SELEY, H. H. VAUGHAN, T. S. LLOYD, T. W. DEMAREST, L. R. POMEROY.

EDITOR'S NOTE.—Because of its importance this paper is reprinted nearly in full.

Labor-saving seems to be the keynote in the development of most all recent shop plans. Central power plants with all the latest improvements in the way of coal and ash handling machinery, automatic stokers, direct-connected generators and engines, the latter compounded and in some cases condensing, are almost the rule.

The one thing that has contributed most to economize movement of materials is probably the electric traveling crane, lifting a single part or perhaps a whole locomotive, carrying and traversing at desirable speeds over the area covered by the span and travel, hoisting and lowering at will great weights with slow, safe speeds and by auxiliary hoists doing rapid work with light weights.

SYSTEMS AND METHODS.

The designer of a new railroad shop at the present time, in arranging for the generating station and power transmission, is primarily confronted with the problem of deciding which system of electrical power distribution to use, alternating or direct current. Each has its strong advocates, who can advance numerous points in favor of their preferred system, and the question is frequently complicated by local conditions to an extent which makes a decision extremely difficult. It may be necessary to combine in the power plant for the shop a generating station for furnishing current for light or power to other company property, passenger depots, freight houses, car repair plants and similar uses, which are located at a considerable distance. For such purposes alternating current is recognized as being an economic necessity, the cost of copper required to transmit the energy by a low-voltage, direct-current system being practically prohibitive. In another instance the converse of this may be the case: in place of the power plant being required to transmit power to a distance or furnish current for uses other than shop operation, it may receive its power from some outside source, in which case it becomes merely a transforming station to convert the current transmitted, which it may be assumed is a high-potential alternating current, into a form suitable for distribution around the shops. In either case the conditions are identical in one respect: alternating current is necessarily used in the power plant; and in both cases also direct current can also be furnished for shop purposes if desired, either by the use of rotary transformers or motor generators, or, in the first instance, by the installation of direct-current generators for shop use separate from those used for the long-distance transmission.

On the other hand, no long-distance problems may interfere with the choice of a system, the power plant may be entirely used for furnishing energy to a group of shop buildings sufficiently near together to make a low voltage reasonably economical, and whichever system is used is selected solely with reference to its presumed advantages for shop driving.

The above instances represent the effects of local conditions, and while they may be modified in the first examples by the proportion of the total power required for shop or outside purposes, there are evidently two possible general conditions to consider: First, where it is necessary that alternate current be present in the power house; second, where it is not necessarily present.

Now, whichever of these two conditions confronts the designer, there is one important fact which affects the problem in the present stage of the development of the alternate-current motor, namely:

That if electrical speed control is desired, direct current must be used for driving those tools on which it is employed. Assuming, therefore, for the moment, that it is immaterial which system is used for the operation of cranes, transfer tables and driving machinery in groups or constant-speed tools, the really important question to be decided is whether or not electrical speed control in some form or other is desirable. A number of articles on this subject have been written, and they are all worthy of careful perusal and study, but the main question is whether the extra investment necessary is justified by the results obtained. There is no doubt that practically all those connected with shops in which some form of electrical speed control has been installed will speak very favorably with respect to its convenience and the economies resulting from its use, but it certainly entails an extra expense and it is necessary to demonstrate that the benefits received are sufficient to outweigh the additional cost. Usually the possible economies are alone referred to, but a preferable method is to find what increase in output is necessary to compensate for the investment and then discuss whether it may be confidently anticipated that this increase will be obtained. This method of reasoning, which is equally as sound as the other, will be found to fit the case considerably better.

It is difficult to obtain figures from which the additional cost of electrical speed control can be definitely determined, and no attempt has been made to obtain them from the various members of this association, although it would be most valuable if they could be furnished in an intelligent form for the proper discussion of this question. For this report the cost figures of the Collinwood shop of the Lake Shore & Michigan Southern Railway, in which the Crocker-Wheeler multiple-voltage system is employed, have been carefully analyzed, and while the results are not accurately applicable to other shops in which the number and character of the tools may vary, and the method of speed control be different, yet remembering that the larger tools in all locomotive shops have a fairly close similarity and that the tools of each description are employed in about the same proportion, it is fair to assume that, while there would be a variation, it would not be important in the gross result, and this assumption will be confirmed by an inspection of the figures.

To ascertain what percentage of increased output must be obtained to justify the application of electrical speed control it is first necessary to formulate the factors that determine the cost per annum of operating a tool. These are as follows:

1. The direct labor charge per diem.
2. The indirect labor charge, including what are generally known as shop expenses, superintendence, power, lighting, etc.
3. Interest and depreciation charge on the cost of the tool.
4. Interest and depreciation charge on the proportion of cost of machine shop and power plant, including generators, etc.
5. Interest and depreciation charge on switchboard, balancers, wiring, motors and controllers, etc.

Of these factors the only one affected by the use of electrical speed control is No. 5, the others being independent of it. The value of them has been estimated for the locomotive shop at Collinwood from the actual figures of the cost of construction as follows:

1. The direct labor for 300 days at \$2.80 per diem is \$840 per annum.

2. The indirect labor charge may be taken at 20 per cent. This figure is fairly representative of railroad shop practice.

3. Interest may be taken at 5 per cent., depreciation at 10 per cent. This figure may be considered high, but if rate of depreciation is lowered it makes less output necessary to earn the investment on the installation of speed control, and it is desired to be on the safe side. At Collinwood there were 38 tools equipped with multiple-voltage (M. V.) control, total cost \$89,644.34, an average of \$2,360 per tool. Fifteen per cent. of this sum is \$354, the annual charge per tool for this item.

4. The proportionate cost of the building that can be charged against any tool is more or less of a guess; but it is a real charge without question. At Collinwood, where the locomotive-erecting machine shop and boiler shop are under one roof, and the only figures available are the total costs of the entire building, the fairest way is to find the cost per cubic foot of the shop and thus determine the cost of the machine shop itself, dividing this among the various tools in proportion to their cost. This is not exactly correct, but as the more expensive a tool is the more floor space it occupies and the more room is required around it, this method is as fair as possible, and on this basis the cost of the shop, including buildings, heating and lighting apparatus (outside of power plant), cranes, etc., is equal to \$1.03 per \$1 cost of tool. The proportionate cost of power plant is fairly arrived at by dividing the cost of the plant by the horse-power of output and charging this against the tools in proportion to their consumption. At Collinwood the total cost per horse-power of output is \$86, and as the actual consumption of the multiple-voltage tools is 70 horse-power, the amount invested for their operation is \$6,020, or \$158.50 per tool. The total investment under this heading is, therefore, \$2,430 plus \$158.50 per tool. On this amount interest may be charged at 5 per cent. and depreciation at 6 per cent., the life being longer than for tools, the total annual charge per tool thus being \$284.73, say \$284.

5. This item is separated from No. 4, as it includes all charges that vary according to the system of control employed. It includes numerous small items, as follows:

- (a) Proportionate part of cost of switchboard and 220-volt feeders in ratio of horse-power consumption of multiple-voltage tools to total, \$1,226.

- (b) Prorated cost of multiple-voltage portion of switchboard, multiple-voltage transformer and inside feeders in proportion of multiple-voltage tools in machine shop to total, \$2,821.

- (c) Cost of wiring multiple-voltage tools. This is not by any means an easy figure to determine, but has been estimated very closely by obtaining the total cost of labor and material for wiring all tools in locomotive shop, exclusive of the feeders to the distribution boxes, and dividing the labor by the number of tools wired and the material by the horse-power of tools wired. To allow for multiple-voltage tools, each of them is counted as two tools wired and as being of double the rated horse-power. In this cost there was also included the power wiring in each erecting pit, each pit considered as representing one tool of 5 h.p., which is very closely correct. The result of this calculation is that it cost \$480 per horse-power for wiring material, \$18.30 per unit tool for wiring labor.

As there were 38 multiple-voltage tools with a total rated horse-power of 270, these amounts are as follows:

38 tools wired at \$36.60.....	\$1,380.80
270 X 2 h.p. at \$480.....	2,592.00
	\$3,972.80

- (d) The cost of motors actually used on the tools, including controllers, etc., \$12,150.

The total cost of item No. 5 is, therefore:

(a)	\$1,226.00
(b)	2,821.00
(c)	3,972.80
(d)	12,150.00

\$20,169.80

This amount is considered to be subject to 5 per cent. interest and 10 per cent. depreciation, as in the case of the tools themselves, the annual charge thus being \$3,025.50, or \$79.70 per tool.

Recapitulating the above the average annual cost for operating 38 multiple-voltage tools based on the Collinwood construction accounts would be:

Item 1.....	\$840.00
Item 2.....	168.00
Item 3.....	354.00
Item 4.....	284.00
Item 5.....	79.70

\$1,725.70

Now, if multiple-voltage had not been employed the only change in the cost of the plant would have been in item 5; the subdivision costs would become as follows:

(a) There would be no change, it remains..	\$1,226.00
(b) This cost is avoided without corresponding change.	
(c) This cost becomes:	
38 tools at \$18.30.....	\$690.00
270 h.p. at \$4.80.....	1,296.00
	1,986.00
(d) The cost of motors required on the various tools, including starting boxes..	7,200.00

Total \$10,412.00

Fifteen per cent. of this amount is \$1,561.80, or \$41.10 per tool per annum.

The total annual cost of operating a tool is thus \$1,725.70 with electrical speed control, against \$1,687.10 when driven by constant-speed motors, or an increase of 2.24 per cent. In other words, it is only necessary to obtain an increased output of 2¼ per cent. to justify the extra expense.

There is little doubt that anyone who has been connected with a shop in which some such system has been employed would hesitate for a moment in stating that a saving is obtained many times that required to equal the additional cost, to say nothing of the increase in output, but there are objections to the method usually employed in giving the reasons for this economy which is based on the assumption that the production of a tool is proportional to the cutting speed of the work. It is true that in the average belt-driven tool the various changes of speed usually vary by increments from 40 to 50 per cent., but it does not follow that the work performed need vary in any such ratio. In any given material with the same cutting tool, which is being operated to its capacity, the amount of metal that is removed in a given time depends on three factors—the cutting speed, the feed and the cut. These factors are not independent, but with a given feed and cut the tool will stand up satisfactorily at a certain speed, with a different feed and cut the maximum practical cutting speed will vary, and so on. The law connecting these three factors is not yet properly determined, and will probably vary for different materials. This much, however, can be stated, that for medium steel, such as that used for driving axles, crankpins, etc., the amount of metal that can be removed per minute with the same depth of cut and with feeds varying from 1-8 to 1-20, the speed in each case being adjusted to the limit of the tool, does not vary 15 per cent. This may not be the case so closely with other materials, but it is certain that a variation in the feed affects the permissible cutting in every case, and within the limits of a speed variation of 40 per cent. it is possible to so adjust the feeds and cuts that the amount of metal removed per minute is substantially the same. It might be stated, therefore, that, theoretically, it is unnecessary to have small and easily made variations in speed, but there is another and more important side to this question, the practical one of how to get as nearly as possible the maximum product from a tool. If a machine were employed steadily upon work in which the material were of uniform hardness, and the dimensions of the pieces the same, it would probably be possible to get the same output when the speeds vary by 40 per cent. steps as when they vary by 10 per cent. by the adjustment of the feeds and cuts, but even assuming this to be exactly true, it is a condition that does not obtain in the majority of machine shops, and is practically absent in railroad shops. While machines may be classified as to the work they perform, this work varies quite a little in its dimensions on account of the various forms and sizes of the parts used on different classes of engines, and the materials employed are also subject to considerable variation in their cutting qualities. How is the output determined in such a case? With a belt-driven tool the machinist sets his feed at what he considers is right and runs his tool at a certain speed. He may try the next speed higher, which is an increase of say 40 per cent., and finds it is too high. The result will be that he returns to the original speed and the work proceeds at that rate. It might be possible to use a larger feed, but it is very liable not to be done, and indeed outside of a few lathes feed changes cannot be made rapidly and easily, and in many tools are too coarse to be effective. The speed change, when made by belt cones, takes a certain amount of trouble and is very likely not made as often as advisable. In general, it is difficult to adjust an ordinary belt-driven tool to the best cutting conditions, and it may be taken at the best to run as nearly as the cones allow, say within 20 to 25 per cent. of the maximum on the average. Compare this with a tool having electrical speed control. The work is being cut at a certain speed; by the movement of a lever placed conveniently to his hand, the machinist can increase the speed by from 10 to 20 per cent. up to the point at which it is found possible to run. There is no exertion involved, no time wasted, and, in fact, there was no real excuse for not operating the tool at its proper speed. If the work has two or more diameters, it is a matter of a second or so to change to the suitable speed. If the material is harder than usual, the speed reduction is simply that necessary to meet the condition, and not 25 or very likely 40 per cent. more, as may easily be the case on a belt-driven tool. There the man will not be found to shift the belt whenever a change is necessary, and he can hardly be expected to do so; with electrical control the change is so easily made that he should and can be

expected to attend to it. With reasonable encouragement and intelligent control it is fair in this case to assume that on the average the machines can be run within 10 to 15 per cent. of the possible speed, giving an increased output theoretically of at least 10 per cent., and in practical working a great deal more, from the closeness of the speed control alone, to say nothing of the saving of time in the manipulation of the machine resulting from this system. On wheel lathes there is a special advantage, that when one or two hard spots occur in a tire the machine can be slowed over these spots and the speed restored for the balance of the circumference; this feature is not very important to the shop as a whole, but it is quite important on that particular tool.

Another advantage of speed control is the opportunity it affords for a practical system for setting cutting speeds. As above mentioned, this is for any material dependent on the feed and cut, but in the majority of cases in locomotive shops the variation in cut on similar classes of work is not important. Now, by adopting a uniform feed for all roughing work or two uniform feeds, one for heavy and one for light work, the most important variable is eliminated and the speed proposition becomes comparatively simple in place of being exceedingly complicated. The depth of cut is of minor importance within the limits in which it usually varies and by standardizing the feeds it becomes possible to estimate very closely what speed should be employed on different materials and, obtaining a satisfactory output is correspondingly feasible. In such a system it is obvious that the ratio of the actual to the possible product depends on the closeness with which the speed can be regulated, and as a difference of 10 or 15 per cent. in the speed is sufficient to ruin a tool in a few minutes or allow it to run for an hour or more, it is evident that it should be controlled by at least that variation.

In general it may be stated that while close electrical speed regulation may not be theoretically necessary, it presents a practical method of increasing the output from shop machinery that cannot be approached by the old belt-and-cone pulley, and that this increase in output should largely outweigh the slight additional cost, and in any shop where this small increase in outlay can be made in order to effect a substantial economy in operation, in other words, in any shop that is laid out on reasonable business principles, some form of speed control should be applied.

If this proposition is assented to, the use of direct current to a greater or less extent follows as a matter of necessity in the present state of the electrical art, for no contractor is yet prepared to figure on alternating-current variable-speed apparatus, and the point next necessary to determine is the extent to which it is advisable to apply this principle. The factor affecting this chiefly is the extent to which it is commercially advisable to direct-connect tools. If it were decided to direct-connect all tools, an inspection of the figures above presented will show that the limiting factor affecting the application of speed control is not the size of the tool, it is the wages of the operator; the smaller the tool and the less the horsepower required to drive it, the less is the additional expense of applying electrical speed control and there is consequently but little difference in the increase in output required to compensate for the additional investment. On a tool costing \$500 and requiring 3 h.p. to drive it the items, calculated as above, are as follows:

Item No.	With Speed Control.	Without Speed Control.
1.....	\$840.00.....	\$840.00
2.....	168.00.....	168.00
3.....	75.00.....	75.00
4.....	66.00.....	66.00
5.....	69.00.....	34.50

Total..... \$1,218.00 \$1,183.50

a difference of \$34.50, or 2.8 per cent.

The wages of the operator are thus the most important factor, as if, in the case of this tool, they were decreased to one-third the amount the increase in output required would become 5.2 per cent. even at that figure; however, the difference would render the question one of the type of tool and general convenience, and the extent to which direct-connection is advisable is thus the most important. At Collinwood tools were direct-connected for three reasons:

1. Where they were located under cranes to allow of their being placed in the most convenient positions and to avoid countershaft supports interfering with the crane service.

2. On tools above 3 h.p. where the advantages of speed control were considered sufficient to justify it.

3. Where tools were in isolated positions and expense of line and countershafting would exceed cost of applying motors.

The remainder of the tools in the machine shop, 103 in all, are group-driven, and the cost of installing these tools has been analyzed to show how it compares with the cost of direct-connected on one assumption, namely: that no additional price would be demanded by the builders in supplying their tools with suitable attachments.

The 103 tools are driven in eleven groups, the total tool horsepower being 242.5; to drive these tools the group motors have a total of 202.5 h.p., which is larger perhaps than necessary, but was considered advisable.

The cost of the driving arrangement was as follows:

Eleven group motors.....	\$4,550.00
Wiring eleven group motors at \$18.30.....	191.30
Wiring 202½ h.p. at \$4.80.....	972.00
Countershaft supports, line shafts, pulleys, etc.....	6,667.00
Belting	3,881.00
	\$16,261.30

Had these tools been direct-driven the cost would have been as follows:

One hundred and three motors.....	\$12,340.00
Wiring 103 tools at \$18.30.....	1,884.90
Wiring 242½ h.p. at \$5.40.....	1,164.00
	\$15,388.90

This result may appear surprising, but it is even more favorable to the direct-driven estimate than it appears. The roof construction must be appreciably heavier when it is expected to support countershafting than would be the case if simply required to cover the building. Additional members must be incorporated, but this expense we are not in a position to estimate at present. Then no charge is made against belt-driven tools for belt shifters and the cost of applying the belting, which for 103 tools is quite an expense. It would be interesting to obtain figures on the cost of maintenance of belting in this connection. The cost at Air Line Junction shop, a woodworking plant on the Lake Shore & Michigan Southern, has been obtained and found to be 25 per cent. per annum for material alone. This expense would certainly be less in a machine shop, but can be safely estimated to be equal to the increased amount of repairs to the motors. To enable these figures to be fairly understood, it should be stated that at Collinwood the countershaft supports are 6-in. channels, bolted together by separators and bolted to the under side of the roof structure, which was arranged to permit of this without drilling any holes for bolts or other fastenings. The structure on the whole is, therefore, not expensive, and if a cheaper form of support had been adopted the influence in the total cost would not have been sufficient to make belt connection the cheaper. These costs, it must also be understood, refer to a machine shop, where the tools are closely placed and group-driving appears in its most favorable light. In a wood mill or boiler shop, where tools are widely placed, a very rough estimate will show the economy of direct-connection, as in such a case it is far cheaper, to say nothing of the saving in power by not running long and heavy line shafts to drive a few tools intermittently.

The whole question is up to the machine tool builders. If they can furnish tools which can be direct-driven for the same price as when belt-driven, which is largely a question of preparing their designs to meet the demand, then it will cost no more to direct-drive tools than it does to belt-connect them in groups, and when this can be said the advantages of individual driving will make this practice preferable. It is not necessary at this time to go over the many desirable features of this system of power distribution, the flexibility it allows in shop arrangement, the absence of belts and overhead line and countershafting, and other economical advantages will certainly lead to the use of direct-connection unless the cost is prohibitive, and it would certainly appear from the above discussion that with the adaptation of machine tools, the introduction of suitable designs, not only will this not be the case, but that the converse will be true. While it is at this time impossible to make that statement, yet it can be said that direct driving should certainly be employed so far as it is not rendered prohibitive by the cost of motor application, and it would then follow from the earlier portion of this report that electrical speed control should also be largely employed.

There are at present in use a number of different systems of electrical speed control, all of which are probably satisfactory in operation. They have had in the past one decided feature by which they might be classified, the extent to which it was thought necessary to vary the speed of the motor, some systems employing a speed variation of 1 to 2 or 4, others a decidedly larger range of from 1 to 5 or 8. The question is one of the size of motor desirable to employ to drive any given tool and is thus partly commercial, the larger motor required for a wide speed variation being of course more expensive, and partly one of convenience, the smaller range systems requiring additional gear trains on many tools, which can be avoided by increasing the speed variation of the motor, and conversely the larger motors are inconvenient to apply and occupy valuable room in the shop. It may be safely stated that this question is being gradually settled as experience is developed and that a range of 1 to 3 or 4 will be very generally agreed on as the largest it is advisable to obtain by electrical means.

This range is being now obtained under two distinct systems, one in which three wires are used, giving voltages in the ratio of 1 to 2, the other, in which four wires are used, giving voltages in about the ratio of 1, 1-1-3, 1-2-3, 2. It would be possible of course to obtain three combinations of voltages by the use of three wires, but there would be but little advantage in this, unless a greater range than 4 to 1 is required, and so need not be considered. In both these systems intermediate speeds between those at which the motor runs under normal conditions at the various voltages are obtained by the use of field and armature resistance, the difference between them thus becoming the extent to which this form of control is employed. There is, however, a considerable difference between the results obtained by field and armature regulation; the former does not affect the speed-maintaining qualities of the motor, and the extent to which it is advisable to use it depends in its effect on the commutation and internal loss of the motor. Armature regulation, on the other hand, depends on its stability on a uniform load being carried by the motor, a condition that does not obtain in the machine-tool driving. If sufficient resistance is introduced into the armature circuit to reduce the speed 20 per cent. at full load, the speed will be but slightly reduced at no load, while if the motor is working at 100 per cent. overload, as it may easily be doing for short periods, the speed will be reduced approximately 40 per cent. in place of 20 per cent. Such a condition is frequently found in practice and it is doubtful whether regulation of speed by armature resistance should be allowed to a greater extent than 8 or 10 per cent. on account of this action. This does not apply to motors operating cranes or similar machinery, and on account of this action, by which the voltage across the motor terminals is reduced when any heavy loads are taken, the use of a certain amount of armature resistance may be recommended on planers and other tools in which a large amount of power is taken at the instant of reverse. On a test of a 42 x 42-in. planer, at the Collinwood shops, it was found that the introduction of resistance equal to 20 volts at full load reduced the current taken at the instant of reversing 50 per cent., without seriously affecting the speed during the cutting stroke. As this class of tools is the one giving most trouble when direct-driven, it would appear advisable in all cases to insert a small amount of resistance in the current

to obtain this action. In general, however, the above remarks hold good, and a variation of 10 per cent. is the limit to which this class of regulation should be used, or the speeds obtained by it will not be reliable.

On the three-wire system it is therefore necessary to obtain the speeds intermediate between those obtained from the direct voltages by field regulation up to a point that is within 10 per cent. of the higher voltage speed, or, in other words, a speed variation of 80 per cent. must be obtained in this way. This was previously thought impossible, the maximum practical increase in this method have been assumed to be about 30 to 40 per cent. During the past year or so, motors have, however, been developed that allow of this amount of regulation, and with this improvement the three-wire system becomes a serious rival to the four-wire. These motors, which are special, are stated to develop a constant horsepower over a range of 100 per cent., so that, commencing, for instance, at a speed of 250 revolutions per minute at 110 volts, the speed is increased, by field weakening, up to 500 revolutions per minute. The speed with normal field at 220 volts is also 500 revolutions per minute, so that by running at that voltage the field can again be weakened until a speed of 1,000 revolutions per minute is obtained. To illustrate these conditions the diagram Fig. 1

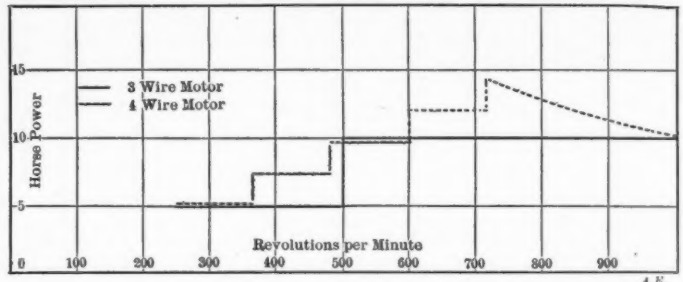


FIG. 1.—HORSE-POWER DIAGRAM FOR MOTORS ON THE 3 AND 4-WIRE SYSTEMS.

has been prepared, on which is shown in full lines the horse-power developed by such a motor at a varying number of revolutions. To make a comparison with the motor used on a four-wire system having the same range, 4 to 1, the same speeds and same minimum horse-power, the dotted lines on this diagram give the same information for that case, in which 40 per cent. variation in speed is obtained by field weakening. This does not represent the practice actually recommended by the manufacturers, but is what would be furnished to obtain the same range and number of revolutions. This diagram shows up several points. First, that the same general size of motor is required by both systems to do the same work, since evidently in this case each requires a motor that will develop 10 h.p. at 500 revolutions per minute, although the four-wire motor is capable of developing more at a greater speed, which the three-wire is not. It is fairly accurate to say, however, that the size of motor depends on the horse-power developed at a given speed, so that in this respect both systems are uniform. One point in this connection is worthy of notice. The three-wire motor develops 10 h.p. at 500 revolutions per minute. At that speed it will also develop 5 h.p. working on the lower voltage. Now, under the latter condition the current is the same, the speed the same, and the field is weakened 50 per cent. This is a condition under which the commutation would be equivalent to a motor working under 100 per cent. overload with normal field, if the motor were of ordinary construction. Your committee does not wish to go into the technical questions involved in this fact, but would call attention to it, as it is important. There are two factors affecting the horse-power that can be developed by any given motor, the heating and the commutation. The latter is the condition that on ordinary motors first gives trouble. If then it is intended to install a three-wire system with this method of speed control, special attention should be given to the capacity of the motor for commutation when working with weak fields, especially when overloaded under those conditions. It certainly requires a motor specially designed for this work, and it would not appear possible to adapt a standard motor to it.

Secondly, this diagram shows that while the three-wire system gives apparently equal results to the four-wire on tools requiring constant horse-power, it is inferior to it on tools in which the horse-power varies with the speed, such as, for instance, planers, slotters, shapers, etc. As these tools are not, however, in a majority, this feature is not perhaps of sufficient importance to seriously influence the question.

Again, the four-wire system affords, under the majority of conditions, greater power from the same sized motor than does the three-wire. If the motor is large enough under all conditions this is not important, but in a great many cases it will be found that unless motors are all installed that are of ample size, which means a relatively expensive plant, all the power that you can get out of a motor is a good thing to have, and this feature must be taken as an advantage in favor of the four-wire system. On the whole, this discussion is rather in favor of the latter, but there are some other points on the side of the three-wire that should not be overlooked. While requiring specially designed motors in place of the standard motors that are used on the four-wire system, it is possible to so arrange the generators that the plant is independent of the operation of a balancing set. This would be a very considerable advantage, as, while a balancing set gives no trouble whatever in operation, if any accident should happen to it all tools dependent on the intermediate voltages for their operation would be put out of service, and in a large plant it would appear desirable to install it in duplicate. The three-wire system also simplifies the lighting problem to a certain extent and affords what is practically a three-wire system for that purpose. Your committee in general feels that on this subject the time is not ripe for any

definite statement; the two systems referred to are both coming into use and their merits will be decided on the field of service. The chief features on one side and the other appear to be, the use of a special motor and one extra wire on the one side as against a standard motor and two extra wires on the other. There does not seem to be any great advantage in cost on one side or the other so far as investigation of the regular prices can determine where the cost of wiring is considered, and apart from this question, which is, perhaps, the most important one in the long run, the points deserving careful attention in considering the design of a plant would be the equal capacity of the motors offered for standing overloads so far as both heating and commutation are concerned, the speed of the motors at the maximum, which for equivalent cost it is desirable to keep equally low, the controller employed, the latter being quite an important detail of the apparatus, and the elimination of armature regulation beyond all limits referred to.

Beyond this discussion as to the system to be adopted for machine-shop driving which is decided by the above considerations, your committee does not feel that it desires to open the question of direct versus alternate current for the purposes in which speed control is not required, believing that since technical discussions on this subject before societies of electrical engineers do not appear to have ever been productive of any definite results, it is hardly worth while approaching from the standpoint of those who are

not electricians, and would leave it to the question of convenience and local conditions by which it is so strongly affected after the driving of the locomotive machine shop has been disposed of.

STATISTICS AND DATA.

The efforts of the committee to compile complete and full data has been frustrated by the lack of exact information, although every possible effort to obtain same has been made, but it is hoped that before the paper goes into the Proceedings in permanent shape, any errors due to insufficient data will be corrected. Five or six shops are in process of erection at the present time, while three or four others are in a preliminary stage; consequently, none of these could be included in the table. (Not reproduced.—Ed.) It has been the endeavor of the committee to ascertain the "load factor" of the different schemes, but this could be obtained in a few cases only, owing to insufficient data. By load factor is meant the relation between the capacity of generators (after deducting the constant or fan loads, the average lighting load, etc.) and the variable loads, such as shop tools. The figures obtained seem to show that if 40 per cent. of the aggregate horse-power of the tools is taken and to this are added the constant and the average lighting load, we have a figure which will represent the generator capacity required without the necessity of taking into the account the cranes transfer or turn-tables. In this connection a spare unit should receive consideration.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

STEAM AND AIR LINE CONNECTIONS.

COMMITTEE—H. F. BALL, T. W. DEMAREST, J. T. CHAMBERLAIN.

In considering the subject your committee broadened the scope of the work, including in its investigation the size of steam train pipe and other data which had a direct bearing on it. We were led to do this with the view of recommending a standard size of pipe as well as location of connections, all of which, if adopted by the association, would permit of changing the present equipment at one time and at least expense.

With one exception all of the roads represented in the replies to the circular of inquiry are using 1½ in. diameter steam train pipe. This size of train pipe was adopted by many roads when steam for heating their passenger trains was first introduced and when trains consisted of six and eight cars. With the use of heavier locomotives the length of trains has been practically doubled, but with no corresponding increase or change in diameter of train pipe, with the result that on some roads, pressures for heating trains are being used up to 90 and 100 lbs., and with results not entirely satisfactory.

It is difficult to heat the rear cars of long trains; excessively long stops are required at division terminals to get steam through the train after changing engines, and with the high pressure used, the steam hose is subject to more rapid deterioration, resulting in delays on the road from burst steam hose, not to say anything about the increased cost of maintenance.

The time appeared opportune to consider the matter of enlarging the diameter of the steam train line, and with this in view a series of tests were conducted at Collinwood, Ohio, on a train of sixteen passenger coaches during the months of February and March.

The tests may properly be divided into four principal investigations, namely:

1. The investigation of the steam hose coupling, or a comparison between gasket openings of 1½, 1¼ and 1⅜-in. diameters with regard to their "steam obstructing" qualities in connection with 1½ and 2-in. diameter train pipes.

2. The investigation of the train line, or a comparison between a 2-in and 1½-in. train line with regard to their "steam obstructing" qualities, and their abilities to maintain a line pressure and provide steam to the radiators.

3. The investigation of the admission valve, or a comparison between a valve having a 1-in. diameter opening and one having a ¾-in. diameter opening, to determine their "steam obstructing" qualities (when open) on the train line, and their abilities to provide steam to the radiators.

4. The investigation of steam pressures, or a comparison between the effect of low pressure on the 2-in. line and high pressure on the 1½-in. line.

The apparatus for making these investigations consisted of the following: A train of sixteen 52-ft. passenger coaches, total length of train being about 900 ft., each car being equipped with both the 2-in. and 1½-in. train pipe.

The cars were provided with 1-in. steam inlet controlling valves, and for the ¾-in. diameter inlet opening, connection was broken and a copper gasket used with a ¼-in. diameter hole in it.

New steam gauges, carefully calibrated, and located about the center of each car, were provided.

Each car was equipped with three thermometers, one at each end and one in the center of the car, suspended from the ceiling. Thermometers were carefully calibrated.

The train was placed on a special track near the power house of the Collinwood locomotive shop plant, in an exposed position, running east and west and having nothing on either side for its entire length to obstruct wind and weather.

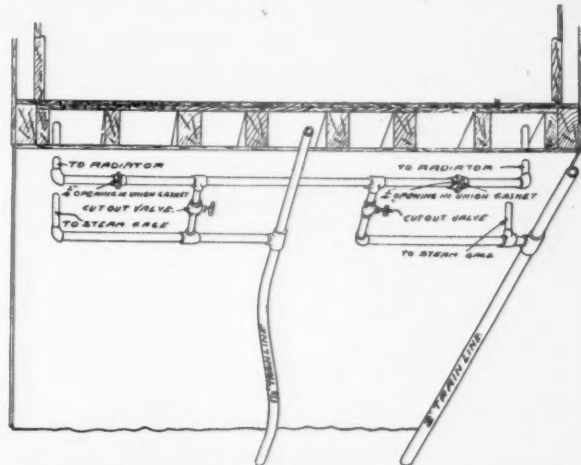
Steam at 150 lbs. pressure was obtained through a 3-in. line from the power house, connection to the train being made exactly as with a locomotive, namely: a globe valve and 1-in. pipe to pressure regulator and 1½ or 2-in. pipe outlet to train line, with steam gauge. Between the regulating valve and end valve of train, connection was made with a ¾-in. air pipe with globe valve; through this line air at 90 lbs. pressure was obtained for blowing out steam

pipe, to obtain constant temperatures at the termination of tests.

In the log of results, the tests are classified in alphabetical order and will be referred to in that manner. Many of the tests were conducted at night time, with a view of getting constant temperature conditions.

[EDITOR'S NOTE.—The tests revealed a marked advantage in the use of 2-in. train line in all of the comparisons.]

In deciding upon localities of steam, air brake and signal connections it was found impracticable to establish fixed positions for these parts that could be adopted by all roads. Platform and draft gear designs not being alike on all roads renders the subject a very difficult one to treat. It was therefore deemed best to establish positions for steam heat, signal and air brake only, with relation to each other horizontally, and back from inside face of knuckle, to which all or nearly all can adhere. Then within certain limits, the air brake and steam heat pipes can be adjusted



ARRANGEMENT OF PIPING USED IN THE TESTS.

vertically or all the pipes can be shifted horizontally, providing their relative locations are maintained. This method provides sufficient flexibility to permit of the proposed locations being followed on any design of platform and when so arranged the connections will hang properly when coupled together.

RECOMMENDATIONS.

Your committee would recommend for adoption as recommended practice the following:

Two-inch steam train pipe; end train pipe valves; steam hose, 1½-in. inside diameter and of such length as to provide 31 ins. from face of coupling gasket to end of hose nipple; 1½-in. steam hose couplings with gaskets having 1½-in. diameter opening, gaskets to be so constructed that the normal diameter of opening will always be maintained; couplings not provided with gravity traps; inlet valves to have reduced openings which should be as small as possible and maintain the volume of steam required by the radiating pipes for the severest weather conditions, steam heat, air brake and signal connections to be located as shown on diagram; air brake and air signal hose to be 1-in. diameter and 22 ins. long.

COLLARLESS JOURNALS.

COMMITTEE—F. W. BRAZIER, E. D. NELSON, F. H. CLARK.

Your committee to consider and report upon the use of collarless journals prepared and submitted to the members a circular embodying questions in order to collect data on which to base its report to the convention:

Replies from thirty-one members, representing 640,608 freight and 14,629 passenger cars, show that 2 per cent. of the freight and 15 per cent. of the passenger equipment represented are equipped with collarless journals.

Thirty-one per cent. of the passenger and 2 per cent. of the freight cars represented in the replies were equipped with collarless journals, whereas 26 per cent. of the hot boxes on passenger and

1 per cent. of the hot boxes on freight cars were on the cars equipped with collarless journals.

All roads, but one, advise that they are using the same dust guards and lids, for both passenger and freight cars, with collar and collarless journals.

All roads state the same kind of bearing is used with both kinds of journals.

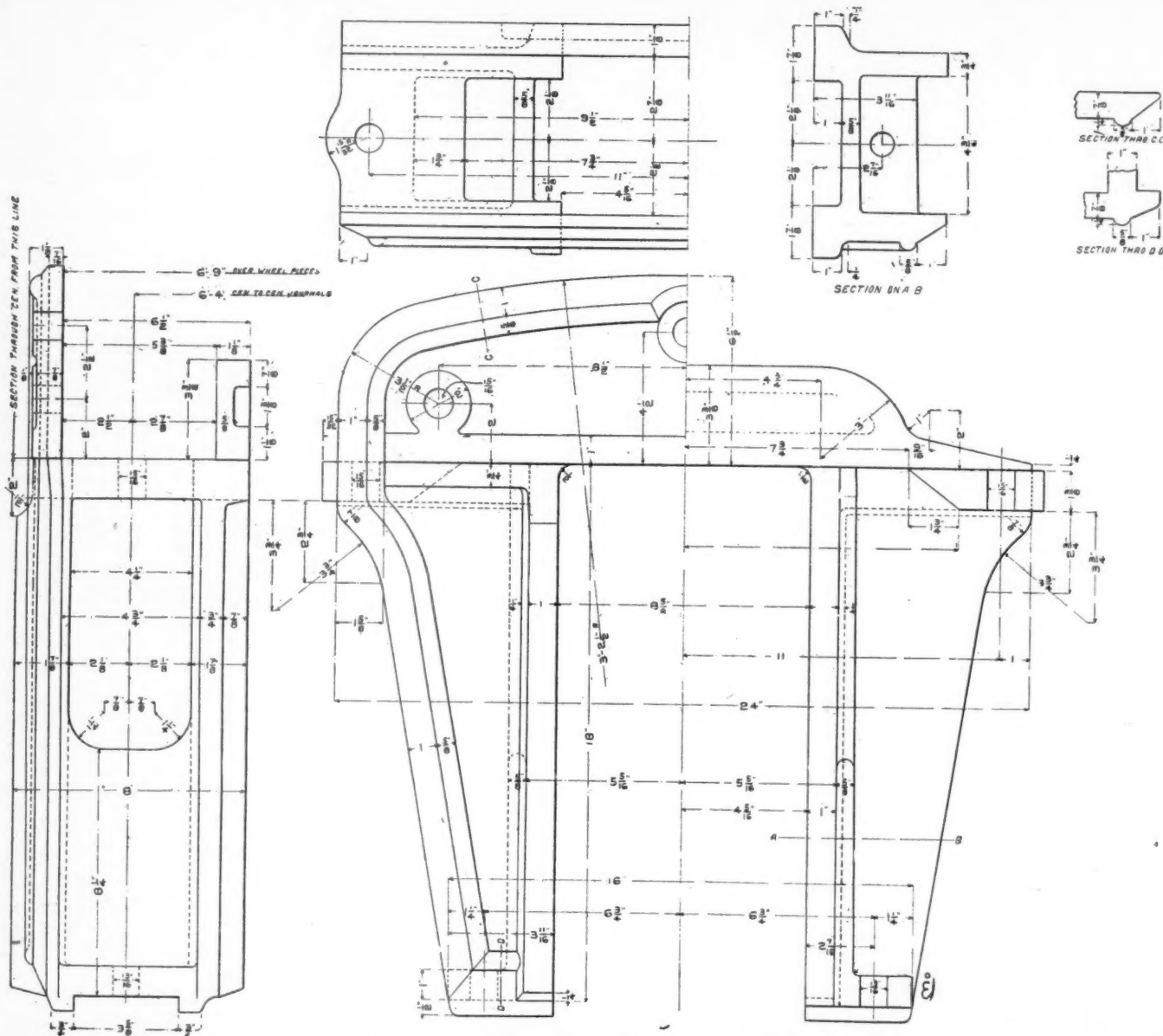
Replies cover 135 cases of broken journal under freight cars with collar journals, and eight under cars with collarless journals; no cases reported of broken journals under passenger cars during the period mentioned.

Of the members representing cars equipped with collarless journals, who made reply, nine advise it is more difficult to inspect the journal bearings on account of the journal bearing keys used with

that, in most cases, the cause of hot boxes is the bad condition of the packing at the side and rear of the box, and that the only remedy is a systematic and efficient treatment of the packing to overcome the glazed or hardened condition resulting from too long contact with the journal, rather than by applying more oil.

In view of the foregoing facts your committee is of the opinion, based upon past experience, that the M. C. B., or collar type of journal, is almost a necessity to insure intelligent inspection and proper care of the packing in the journal boxes.

We also wish to call attention to the excessive end play with the collarless journal, allowing the brass to swing out over the end of the journal, thereby bringing the load farther from the fulcrum and causing a greater strain on the axle than is the case with the collar journal where the end play is limited.



PROPOSED STANDARD PEDESTAL FOR 5 BY 9-IN. JOURNALS.

the collarless journal, and five that there was no difficulty experienced.

Nine members reply that trucks keep square as well with the collarless journals as with the collar journal, and five members advise that they do not.

Your committee desires to call attention to the fact that the end of the journal bearings keys used with the collarless journal not only prevents proper inspection of the journal bearing and packing, but certainly interferes with the oilers giving to the packing, an important term, the attention necessary to maintain the efficiency of the packing. This is more particularly true of the packing at the side and rear of the box, which can be readily appreciated by all who are familiar with the conditions surrounding this type of journal, due to the lack of space between the side of the journal box and the journal. This feature of maintaining the elasticity of the packing is becoming more essential with the increased loads and speed of trains of the present day, in order to overcome hot boxes, the danger of which is increased with the speed of the train.

It has been thoroughly demonstrated that the highest efficiency in lubrication is obtained, not by the simple process of adding more oil to the box, but by thoroughly maintaining the packing in a loose and elastic condition in order that the oil may be freely conveyed from the packing to the journal. It has also been shown

PROPOSED STANDARD PEDESTAL AND JOURNAL BOX FOR PASSENGER CARS FOR 5 BY 9-IN. JOURNALS.

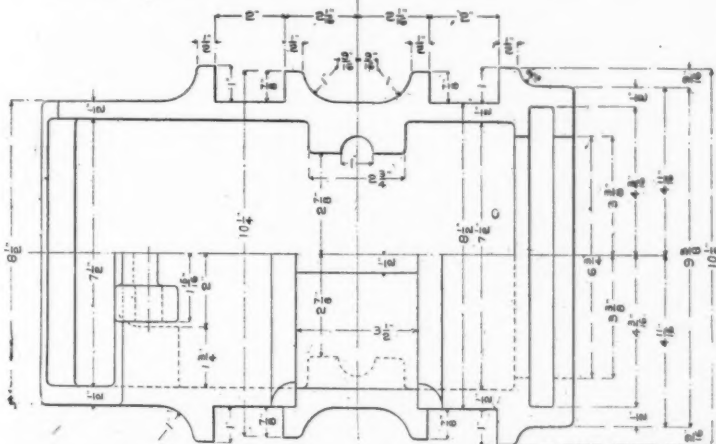
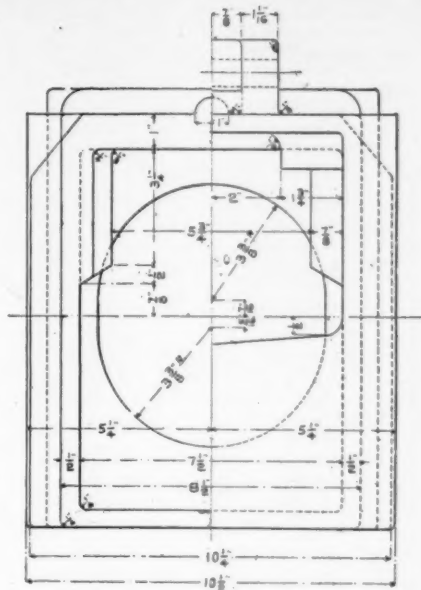
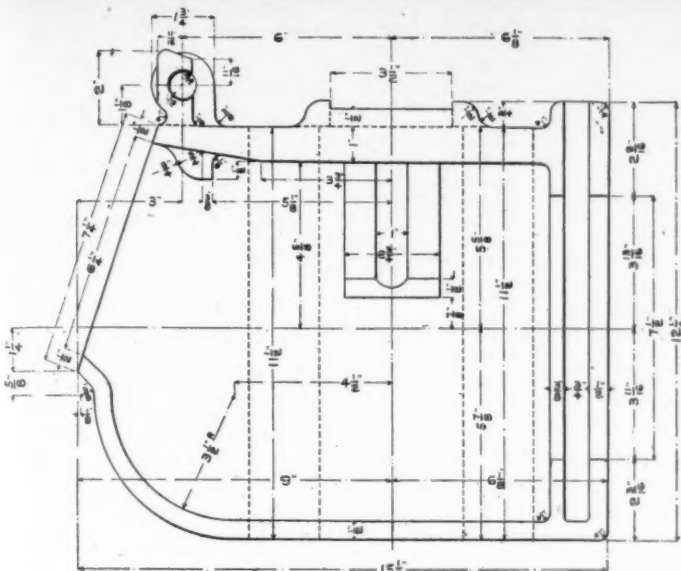
COMMITTEE—J. R. SLACK, T. B. PURVES, JR., WM. RENSCHAW.

Your committee, appointed to submit a proposed design for Pedestal and Journal Box for Passenger Cars for 5 by 9-in. Journals, beg to submit designs as shown on the accompanying drawings.

LABORATORY TESTS OF BRAKE SHOES.

COMMITTEE—CHARLES COLLIER, WM. GARSTANG, W. F. M. GOSS.

Since the presentation of the last formal report of your committee on Laboratory Tests of Brake Shoes, in June, 1901, four shoes have been tested by your committee; three of these were submitted on behalf of the Michigan Central Railway by Mr. E. D. Bronner, Superintendent of Motive Power, and one on behalf of the C., B. & Q. R. R. by Mr. F. H. Clark, Superintendent of Motive Power. The actual work of testing was performed by the authorities of the engineering laboratory of Purdue University, under the immediate direction of Edward Reynolds, Associate



PROPOSED STANDARD JOURNAL BOX FOR 5 BY 9-IN. JOURNALS.

Professor of Experimental Engineering, in accord with the standing arrangement existing between your committee and Purdue University. All results were duly reported to your committee, and thence transmitted to the parties interested. The characteristic mark borne by each shoe tested, the number assigned it in the laboratory, the date upon which the report was rendered, and the road submitting the shoe, are all shown by Table I.

TABLE I.

Mark on Shoe.	Lab. No.	Date on which Report was Rendered.	By Whom Submitted.
R. W. & F. Co.	79	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
R. W. & F. Co.	80	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
R. W. & F. Co.	81	Aug. 22, 1902....	Michigan Central Ry. Co., by E. D. Bronner, S. M. P.
Walsh	114	May 2, 1903	C. B. & Q. R. R., by F. H. Clark, S. M. P.

Shoes Nos. 79, 80 and 81 were all of close-grained material, apparently iron, and except for the presence of blow holes, they were solid throughout their structure, no inserts being used. While they were to be regarded as hard shoes, no portion of them was chilled, and no difficulty was experienced in piercing them in any direction with a drill. The dimensions of the shoes were identical. When worn down to fit the wheel, their faces were $3\frac{3}{8}$ by $13\frac{1}{2}$; their length being measured on the arc. Upon the conclusion of the tests, the shoes were drilled and split lengthwise and photographs made both of the face and the fracture thus obtained. An examination of the fracture shows no perceptible difference in the structure of the several shoes. The fragments of the shoes are preserved, for the present, in the laboratory of Purdue University.

No. 114 was one of a lot of five sent to the laboratory, all of which were supposed to be alike. It is of soft cast iron having two pear-shaped inserts of hard metal, the outline of which appears upon its wearing face. All parts of the shoe, except the hard insert and the metal in its immediate vicinity were easily machined. The shoe was cast to fit a 36-in. wheel, and, therefore, required to be planed and ground down to an approximate fit to the 33-in. wheels used on the testing machine before any applications were made. Each insert is provided with a lug extending entirely through to the back of the shoe, and the body of the shoe is strengthened by two steel rods which extend lengthwise through it. The dimensions of the face of the shoe are $3\frac{1}{2}$ ins. wide by 14 ins. long, as measured on the arc. The total area of contact is, therefore, 49 sq. ins., of which $9\frac{1}{2}$ sq. ins., or about 20 per cent., is made up of the hard inserts, while the remaining 80 per cent. is of the soft cast iron forming the body of the shoe.

The routine of testing shoes was greatly simplified by the adoption, in June, 1901, of a standard specification which permits all

tests upon a cast-iron wheel to be made from a speed of 40 miles an hour, and all tests upon a steel-tired wheel from a speed of 65 miles an hour. The process of testing under each condition specified has not been changed. Each shoe was brought into full bearing with the wheel by trial applications prior to the beginning of the formal tests. The usual precautions were taken to avoid overheating, both of the shoe and wheel, an air blast being used between every two or three applications.

The specifications of the Master Car Builders' Association provide that shoes when tested on the Master Car Builders' testing machine in effecting stops from a speed of 40 miles an hour shall develop a coefficient of friction which upon a chilled wheel shall not be less than

- 22 per cent. when the brake-shoe pressure is 2,808 lbs.
- 20 per cent. when the brake-shoe pressure is 4,152 lbs.
- 16 per cent. when the brake-shoe pressure is 6,840 lbs.

Also, that shoes when tested on a steel-tired wheel from a speed of 65 miles an hour shall develop a mean coefficient of friction which shall not be less than

- 16 per cent. when the brake-shoe pressure is 2,808 lbs.
- 14 per cent. when the brake-shoe pressure is 4,152 lbs.
- 12 per cent. when the brake-shoe pressure is 6,840 lbs.

The specifications also provide that the rise in the value of the coefficient of friction at the end of the stop will be within such limits that the value of the coefficient of friction for a point 15 ft. from the end of the stop will not exceed the mean coefficient of friction by more than 7 per cent.

A summary of the results obtained appears as Tables II. and III.

TABLE II.

COEFFICIENT OF FRICTION—PER CENT.

		Steel-Tired Wheel.				Chilled Wheel.			
Brake Shoe Pressure.	Value Specified.	79	80	81	114	Value Specified.	79	80	81 114
2808	16	14.4	15.9	15.5	15.1	22	20.	19.6	19. 25.
4152	14	12.7	12.9	13.6	14.1	20	16.3	18.1	17.4 25.4
6840	12	11.2	11.3	11.6	13.3	16	15.3	15.3	15.9 22.5

TABLE III.

RISE IN VALUE OF COEFFICIENT OF FRICTION, 15 FT. FROM END OF STOP.

		Steel-Tired Wheel.				Chilled Wheel.			
Brake Shoe Pressure.	Value Specified.	79	80	81	114	Value Specified.	79	80	81 114
2808	7	11.6	9.9	12.5	8.1	7	8.4	8.6	9. 5.3
4152	7	8.8	7.9	9.5	11.7	7	9.4	10.9	11.1 6.5
6840	7	6.2	7.1	6.9	7.4	7	6.4	8.6	5.9 3.7

The behavior of each shoe tested with reference to smoothness of action upon the wheel appeared normal in every way. There was no chattering, neither was there evidence of excessive wear upon the wheel. Shoes Nos. 79, 80 and 81 developed substantially the same coefficient of friction upon the chilled wheel, while upon the steel-tired wheel their performance was in the order in which they are numbered, No. 79 being the poorest, and No. 81 the best. The coefficient of friction developed by each of these shoes is below the requirements of the specifications, while the rise in the value of the coefficient at the end of the stop exceeds the limit allowed. No. 114 developed a coefficient of friction in excess of that specified in all but one case, and the rise in the value of the coefficient of friction at the end of the stop is well within the specified maximum when used upon the cast-iron wheel, but is in excess of the allowed limit when used upon the steel-tired wheel.

EXHIBITS AT THE CONVENTIONS.

- Acme Supply Company, Chicago, Ill. Showing vestibule diaphragm.
- Adams & Wastlake Company, Chicago. Adlake acetylene gas car-lighting system.
- American Balance Valve Company, Jersey Shore, Pa. American balanced slide valves, American balanced piston valves, the J. T. Wilson high pressure balanced valve, the American Metallic piston rod and valve stem packing, the Nixon safety stay-bolt sleeve.
- American Brake Shoe & Foundry Company, New York and Chicago. Railway brake shoes.
- American Steam Gauge & Valve Company, Boston, Mass. Showing steam gauges and locomotive pop safety valves.
- American Steel Foundries Company, New York and St. Louis.
- Aurora Metal Company, Aurora, Ill. Showing the Lewis & Kunzer metallic piston packing.
- Baltimore Railway Specialty Company, Baltimore, Md. The "Norwood" ball bearings, center and side bearings.
- Besly & Co., Charles H., Chicago. Taps, parallel clamps and Gardner grinders.
- Bordo, L. J., Philadelphia, Pa. Showing the Bordo blow-off valve and Bordo appliances.
- Boston Belting Company, Boston, Mass. Showing an extensive exhibit of air brake hose and other material.
- Brady Brass Company, New York, N. Y. Cyprus bronze for locomotive and journal bearings.
- Buckeye Malleable Iron & Coupler Company, Columbus, Ohio. The Major automatic coupler.
- Buffalo Forge Company, Buffalo, N. Y. Buffalo fans for mechanical induced draft, down draft forges, blowers and exhausters for shop equipment.
- Coffin-Megeath Supply Company, Franklin, Pa. Showing car coupler.
- Chicago Pneumatic Tool Company, Chicago, Ill. Full line of pneumatic hammers and drills and other pneumatic tools.
- Commonwealth Steel Company, St. Louis, Mo. Models of trucks and separable bolsters.
- Consolidated Railway Electric Lighting & Equipment Company, New York. Exhibiting on D. & H. tracks electric lighted Pullman car, "Elysian."
- Crane Company, The, Chicago, Ill. The new Crane locomotive muffler pop safety valve, gun metal globe and angle valves and blow-off valves for high steam pressure.
- Crocker-Wheeler Company, The, Ampere, N. J. Showing photographs of motor equipped machine tools and bulletins.
- Damascus Brake Beam Company, St. Louis, Mo. Damascus brake beams.
- Dayton Malleable Iron Company, Dayton, O. Dayton draft gear, Dayton patent car door fastener, lubricating center plate.
- Detroit Lubricator Company, Detroit, Mich. Exhibit of lubricators.
- Edwards Company, The O. M., Syracuse, N. Y. Showing fourteen designs of window models, recent improvements, six models of extension platform trapdoors for wide vestibules and open platforms for railroad coaches.
- Franklin Manufacturing Company, The, Franklin, Pa. Showing asbestos dust guards, asbestos-magnesia molded boiler covering, asbestos train pipe covering.
- Gold Car Heating & Lighting Company, New York, Chicago and London. Car heating apparatus, duplex coil system and straight steam operated under steam.
- Gould Car Coupler Company, New York, N. Y. Improved M. C. B. journal boxes, improved malleable draft rigging for freight equipment with spring buffer blocks; improved M. C. B. coupler for 100,000-lb. car and improved locomotive tender coupler for heavy equipment; steel passenger platform with friction buffer and draft gear. Friction draft gear for freight for wood or steel sills. Improved roller side bearings for freight cars.
- Hammett, H. G., Troy, N. Y. Richardson and Allen Richardson balanced slide valves, oil cups, "Sansom" bell ringer, link grinders and Prendergast metallic packing.
- Handy Car Equipment Company, Chicago, Ill. Showing the Handy swinging pilot coupler, snow car and locomotive replacer.
- Kennicott Water Softener Company, The, Chicago, Ill. Showing water softening apparatus.
- Kindl Car Truck Company, Chicago, Ill. Showing Kindl car truck, Cloud car truck, roller side bearing, pedestal lateral motion.
- Lodge & Shipley, Cincinnati, Ohio. Showing a 24-in. swing, 10-ft. bed, motor-driven engine lathe.
- McConway & Torley Company, Pittsburg, Pa. Steel and malleable iron couplers for freight cars and tenders of the Kelso and Janney patterns.
- McCord & Co., Chicago and New York. McCord journal box, McCord spring dampener, McKim gasket and Torrey anti-friction metal.
- Manning, Maxwell & Moore, New York. Hancock inspirators, check valves, steam valves and strainers for locomotives.
- Manufacturers' Railway Supply Company, Chicago, Ill. Showing interlocking car and driver brake shoes and interlocking driver brake head.
- Merritt & Co., Philadelphia. Showing combination sheet steel ventilated, dustproof sheet steel and expanded metal lockers.
- Michigan Lubricator Company, Detroit, Mich. Lubricator, oil cups and a new triple feed lubricator with new automatic safety device over sight feed glasses.
- Midland Railway Supply Company, Chicago, Ill. Showing the Perry roller side bearings, blue prints and catalogues.
- More-Jones Brass & Metal Company, St. Louis, Mo. Showing Arctic car brasses, Tiger bronze engine brasses, Hoo-Hoo and Rex babbitt metals.
- National Malleable Castings Company, Cleveland, O. Showing the Tower locomotive coupler, the National journal box, National car door fastener.
- National Car Coupler Company, Chicago, Ill. National steel platform and buffer for passenger cars, National freight car coupler, Hinson draft gear and the Hinson drawbar attachment.
- Pittsburg Spring & Steel Company, Pittsburg, Pa. Showing locomotive and car springs.
- Railway Appliances Company, The, Chicago, Ill. Showing the "Stanwood" car step, Ajax vestibule diaphragms, Fewing's car and engine replacer.
- Railway Materials Company, The, Chicago, Ill. Showing Ferguson oil furnaces and Ferguson locomotive fire kindler.
- Rand Drill Company, New York. Showing steam, electric and gas driven compressors; a complete line of Rand pneumatic tools.
- Safety Car Heating & Lighting Company, New York, N. Y. Exhibiting car lighting and heating apparatus. The new features are fancy deck lamps, bracket lamps and a steam heating exhibit showing all the latest improvements in this line, and also buoy lantern.
- Scarritt Furniture Company, St. Louis, Mo. Showing car chairs and seats.
- Simplex Railway Appliance Company, Chicago. Simplex bolsters for 80,000-lb. capacity cars; also for 60,000-lb. cars; Susemihl frictionless side bearing and brake beams for all service.
- Soule Dust Guard Company, Boston, Mass. Showing the Soule rawhide lined dust guard.
- Standard Coupler Company, New York. Standard steel platforms, Sessions' standard friction draft gear, Standard couplers.
- Standard Car Truck Company, Chicago, Ill. Showing Barber roller bearing truck models.
- Symington Company, The T. H., Baltimore, Md. Showing journal boxes and dust guards.
- Underwood, H. B., & Co., Philadelphia, Pa. Showing catalogue of special tools, boring bars and valve seat facers.
- Washburn Coupler Company, Minneapolis, Minn. Showing freight couplers, flexible head passenger couplers and switch engine couplers.
- Waycott Supply Company, St. Louis, Mo. Damascus brake beams.
- Wellman-Seaver-Morgan Company, Cleveland, Ohio. Showing the Wellman-Street 100,000-lb. capacity steel hopper car, the Wellman-Street cast steel bolster, the Street tandem draft gear, the Street twin draft gear, the Street journal box.
- Whall, C. H., & Co., Boston, Mass. Showing metallic window casings, car ventilator and samples of fiber.
- Westinghouse Air Brake Company, The, Pittsburg, Pa.; The American Brake Company, St. Louis, Mo.; Westinghouse Automatic Air & Steam Coupler Company, St. Louis, Mo.

The Buffalo Steam Pump Company, whose works are at North Tonawanda, has been purchased by Messrs. William F. and Henry W. Wendt, who are also owners of the Buffalo Forge Company and the George L. Squier Manufacturing Company. The North Tonawanda works of the steam pump company are to be continued as heretofore, and the main offices will be in Buffalo.

We understand the records in the clerk's office of the United States Circuit Court for the Northern District of New York disclose the fact that a suit has recently been instituted in that court by the Safety Car Heating & Lighting Company against the Consolidated Car Heating Company for alleged infringement of its patents in connection with car heating devices. We presume this is the outcome of the claims made by the Safety Car Heating & Lighting Company to which reference was recently made in our columns. The suit is evidently one of considerable importance as the bill was filed by Betts, Betts, Sheffield & Betts, of New York City, with Frederic H. Betts, Samuel R. Betts, Edward P. Wetmore and Randolph Parmlay as counsel.

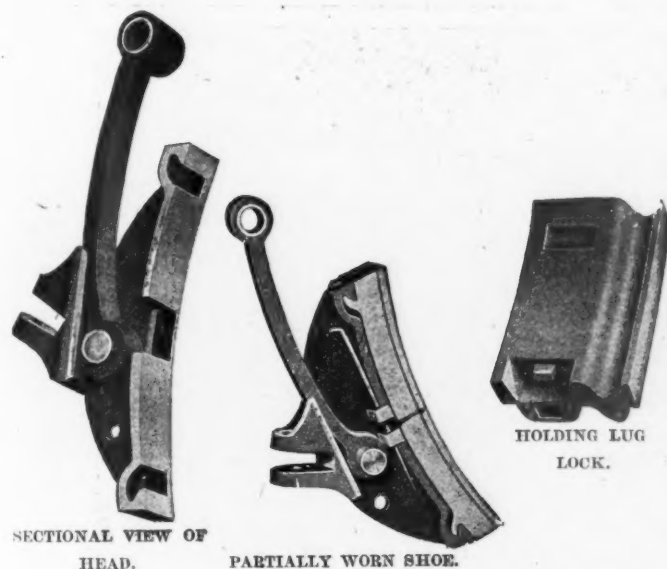
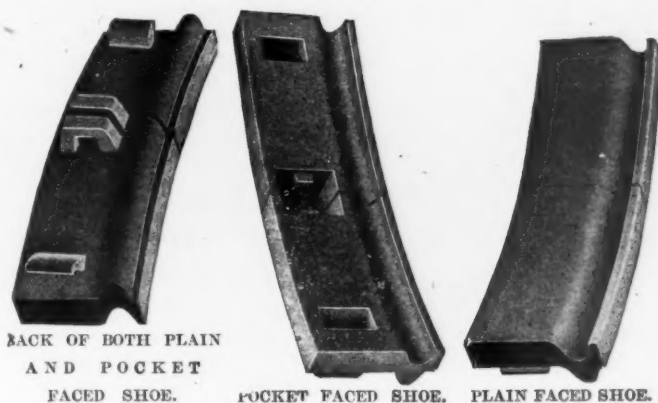
The Norwood side bearings and center plates have been improved in important respects since last year. The general construction is not changed, but provision is made to insert the ball races of the side bearings at the ends of the castings with a dovetail fit, preventing them from raising. The ball race casting is now provided with a motion of one-half inch endwise of the bolster, and adequately secured from further motion by a guide casting secured to the bolster. This permits the side bearings to adjust themselves to an old center plate. The ball bearing center plate is now milled to admit the ball race, the work being done accurately and the parts interchange. These are a few of the improvements seen in the exhibit at the Saratoga conventions of the Baltimore Railway Specialty Co., Calvert Building, Baltimore.

MECHANICAL ENGINEER, experienced in the design, testing and construction of railway mechanical apparatus, including brake shoes, air brakes, couplers and also locomotives and stationary steam engines, desires position as TECHNICAL OR EXECUTIVE HEAD of a large manufacturing or engineering firm. Has experience in the design of power and manufacturing plants and makes a specialty of working out technical processes, systematizing and cheapening methods of production. Can furnish best of references and will consider reliable firms only. Address R., care AMERICAN ENGINEER.

INTERLOCKING BRAKE SHOES AND HEAD FOR DRIVER BRAKES.

Brake shoes are frequently thrown away when but little worn, due to imperfect bearings or uneven wear, which results from defects in the brake gear. When fairly well worn down they are scrapped with a large loss of material which would be overcome by construction which would permit the shoe to be entirely worn through. This the Manufacturers' Railway Supply Company aim to provide in their new interlocking brake shoe, and also to guard against the breakage of shoes by parting them in the center in such a way as to permit of more perfect fitting to the wheel. Many shoes break before they are near the end of a fair mileage because of weakening through wear.

The construction of the shoe and the head required to receive them is clearly indicated in the accompanying engravings. In spite of the expense of the new head, it is stated that the saving



in the wear of the first set of shoes produces a net gain, because driver brake shoes are usually scrapped at one-half their original weight, or, say, between 15 and 30 lbs.; according to their size. An average of 30 lbs. would fairly represent usual conditions. With the interlocking shoe this would be entirely worn out, and the cost of the new head will be balanced by the additional wear of the shoes, while costing much less per pound than the material put into the shoes.

The interlocking shoes for car wheels have already been illustrated in this journal, and it is fair to expect equally satisfactory results in the driver brake shoes. The engraving illustrates the reinforcement of the worn shoes by the old shoes and the head itself. This new construction of brake shoes is entitled to careful investigation. The address of the Manufacturers' Railway Supply Company is Fisher Building, Chicago.

The More-Jones Brass & Metal Co., of St. Louis, distributed graceful souvenirs to the ladies of the Master Mechanics' and Master Car Builders' conventions, in the form of beautiful roses tied with white satin ribbons. The company was represented by Mr. D. A. Campbell.

THE WAYCOTT BRAKEBEAM.

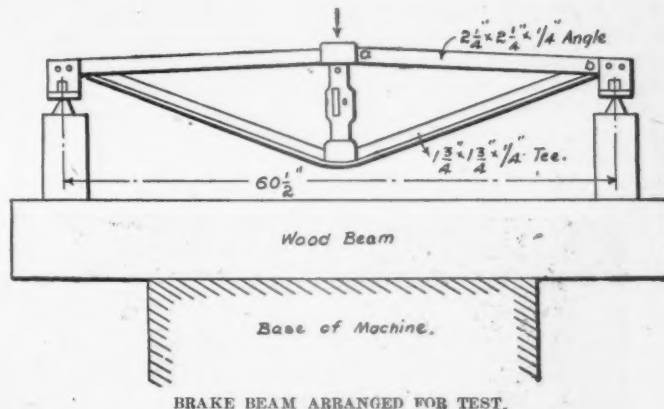
The great success which has been attained by the Damascus brakebeam, which was introduced about eighteen months ago by the Damascus Brakebeam Company, of St. Louis, has induced the same manufacturers to bring out a new beam, which will be known as the "Waycott." The Damascus is a solid beam, and since its introduction has met with such favor as to have caused the sale of over 150,000 beams, which are now in use on a large number of railroads in all parts of the United States.

The Waycott beam is of different construction, as shown, being



a truss beam made of commercial shapes put together in the simplest possible form. The compression member is a $2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$ -in. angle, and the tension member a $1\frac{3}{4} \times 1\frac{3}{4} \times \frac{1}{4}$ -inch tee. The two members are united by heads and fulcrum pieces of malleable iron, the frame being riveted through both members. The hanger eyebolts are attached to clamps which embrace both parts of the beam. The distribution of the metal is admirably arranged so as to give the required strength with a minimum of weight.

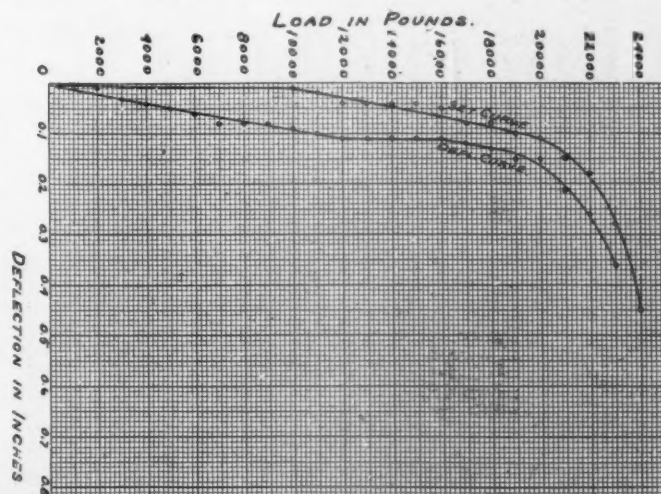
A test of this beam was recently made by the engineering laboratory of Purdue University with very satisfactory results. The



tests were made upon two beams, and the results are given in condensed form as follows:

	No. 1.	No. 2.
Weight of beams in pounds.....	62.5	62.5
Load in pounds at elastic limit.....	20,000	20,000
Deflection in inches at elastic limit.....	.15	.28
Set in inches at elastic limit.....	.11	.17
Load in pounds at point of failure.....	24,000	23,000

In this test the brakebeam was supported on knife edges resting on steel plates, which in turn rested on 15 x 20-in. wood bear supported on the base of a 300,000-lb. Riehle testing machine. The knife edges were placed $60\frac{1}{2}$ ins. apart, being the distance



required by M. C. B. standard from center to center of brakeshoes. Before applying any loads for record, a load of 7,000 lbs. was applied and then removed, this being done in order to take up any free

movement of the parts that might exist in the construction. The load under the test was applied in increments of 1,000 lbs. and the corresponding deflection read with each application. The running log of the test on beam No. 1, is presented below, the set and deflection curves obtained from these records being presented in the above diagram.

RUNNING LOG.
Flexure Test of Damascus Truss Brakebeam.

Load in Pounds.	Deflection in Inches.	Set in Inches.	Load in Pounds.	Deflection in Inches.	Set in Inches.
0	0	0	13,000	0.11	0.04
1,000	0.01	0	14,000	0.11	0.04
2,000	0.01	0	15,000	0.11	0.04
3,000	0.03	0	16,000	0.11	0.05
4,000	0.04	0	17,000	0.12	0.08
5,000	0.05	0	18,000	0.13	0.08
6,000	0.06	0	19,000	0.15	0.10
7,000	0.08	0	20,000	0.15	0.11
8,000	0.08	0	21,000	0.21	0.15
9,000	0.08	0	22,000	0.26	0.18
10,000	0.09	0.01	23,000	0.36	0.28
11,000	0.10	0.02	24,000	*	0.45
12,000	0.11	0.04			

*Compression member buckled at (a) and (b). See diagram of beam as arranged upon the blocks for testing.)

The Consolidated Railway Electric Lighting & Equipment Co., 100 Broadway, always make an impressive exhibit at the mechanical association conventions. This year they had the private Pullman car "Elysian" at Saratoga. This was the car used by President Roosevelt in his recent transcontinental trip and is altogether the finest car turned out at Pullman. It is equipped with the apparatus of this company and was seen in operation in the trips from New York to Saratoga and return by a large number of guests of the company who were invited to enjoy its genial hospitality and inspect the operation of the electric lighting apparatus. While passengers in the other cars of the train were sweltering during a very hot trip the party in this car was made perfectly comfortable by the electric fans driven from the lighting circuits. This company now has 900 equipments in service, 130 of which are on one railroad, the Santa Fe.

A number of improvements in the apparatus manufactured by the American Steam Gauge & Valve Mfg. Company, Jamaica Plain, Boston, Mass., were exhibited at the recent conventions at Saratoga. The exhibit was arranged to show at a glance the wide range of apparatus covered and among the specialties which stood out prominently were the following. A new American Thompson indicator with a convenient detent attachment which will be appreciated by all who use these instruments, another indicator of the same style, with a reducing motion attachment which takes the place of large, awkward and unsatisfactory levers and pantographs, new locomotive pops, in which all adjustments are made at the top, heavy automatic high pressure water gauges, duplex air brake gauges with a solid socket for the springs, locomotive gauges and automatic recording gauges. The exhibit also included test pumps, muffled pops and many other specialties made by this concern, and all arranged in a very attractive way.

The Safety Car Heating & Lighting Company had, as usual, a most attractive exhibit at the Master Mechanics' and Master Car Builders' conventions. It was in the tasteful elegant style which always characterizes the exhibits of this company, and conveyed an impression of combined beauty and utility. In addition to the exhibit of the Pintsch light in the hotel corridor this company had a room fitted up with steam heating apparatus illustrating their latest improvements in facilities for heating cars. They showed their new end valves as applied to a model of a car platform, also the new hose couplings with 1½ inch openings and improved gasket fastenings. Among the other improvements was a new jacket heater in which the steam enters a central tube and doubles back in a surrounding tube, both steam tubes being enclosed in the large outer jacket tube. The results of a test showing the advantages of the 1½ inch openings in hose couplings were exhibited in blue print form. This company is busy with improvements in car heating and those who have not recently made a study of their apparatus will find the subject interesting.



NEW QUARTERS FOR THE BRODERICK & BASCOM ROPE CO.—WIRE ROPE AND TACKLE BLOCK STORAGE.

The Broderick & Bascom Rope Co., of St. Louis, have recently moved into their commodious new quarters at Nos. 805, 807 and 809 North Main street. The illustration presented herewith represents the second story floor of their building at No. 809. On this floor, as shown in the illustration, is carried an immense stock of tackle blocks and wire rope. We feel certain that an array of blocks and reels of wire rope like this, on a single floor, will present an impression of the magnitude of the business done in this line by this well-known firm. There is probably no wire rope concern in the United States that carries, under one roof, a larger assortment of wire rope, blocks and tackle, manila rope and cordage of every description.

The Broderick & Bascom Co. was established in 1875, and incorporated in 1882. They are successors to the old St. Louis Wire Rope Works, both Mr. John J. Broderick, the president, and Jos. D. Bascom, the secretary and treasurer, having had long experience in the wire rope business. When first starting to manufacture wire rope it was made by hand, instead of by machinery. Their former superintendent, Mr. Wm. Mentz, has been a manufacturer of wire

rope from 1840, having made all of the wire ropes that were used by Jas. B. Eads in constructing the renowned Eads Bridge.

The wire ropes are composed of a hempen cord, around which are laid six wire strands, of seven, twelve or nineteen wires, thus forming ropes of 42, 72 or 114 wires. The ropes of seven wires to the strand are most commonly used for standing ropes, guy, ship rigging, transmission of power, mine haulage and for contractors' purposes. These ropes are as flexible as hemp ropes of equal strength, and though weighing less, are far more efficient and durable. A strain of one-seventh to one-fifth of the breaking strain may be taken as a safe working load. In the special power wire rope, made by this company, every wire is thoroughly tested for tensile strength, torsion, elongation and elastic limit, and these tests are registered for reference. The company is prepared to furnish rope from stock one-sixteenth of an inch up to two inches in diameter, and from 5,000 to 20,000 ft. long.

The Broderick & Bascom Rope Co. have a large mailing list, for sending out monthly quotations, and will be glad to add the names of any master mechanic, master car builder or purchasing agent to their list and invite correspondence.